POWER

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Abuse of Engineers' License Laws

SPEAKING of Engineers' License Laws, the laws for the licensing of firemen and operating engineers have undoubtedly been helpful in reducing the number of preventable accidents like boiler explosions, runaway engines, turbines, etc.

They appear to be warrantable and advisable measures of precaution against danger to the public by the careless or incompetent management of power-plant apparatus.

These dangers threaten not only workers in the mills and factories, but patrons of the stores, hotels and theaters—even the passer on the sidewalk beneath which lurk the boilers of the basement plant.

The public would shudder to see some of the death traps that are shut down and thrown out by city, state and insurance inspectors.

They would shudder, too, to see some of the men who would be put in charge of these magazines of energy if there were no legal requirements as to competency and reliability.

These laws are often strained, however, in an effort to misuse them to limit the available supply of labor or to serve some other incongruous purpose.

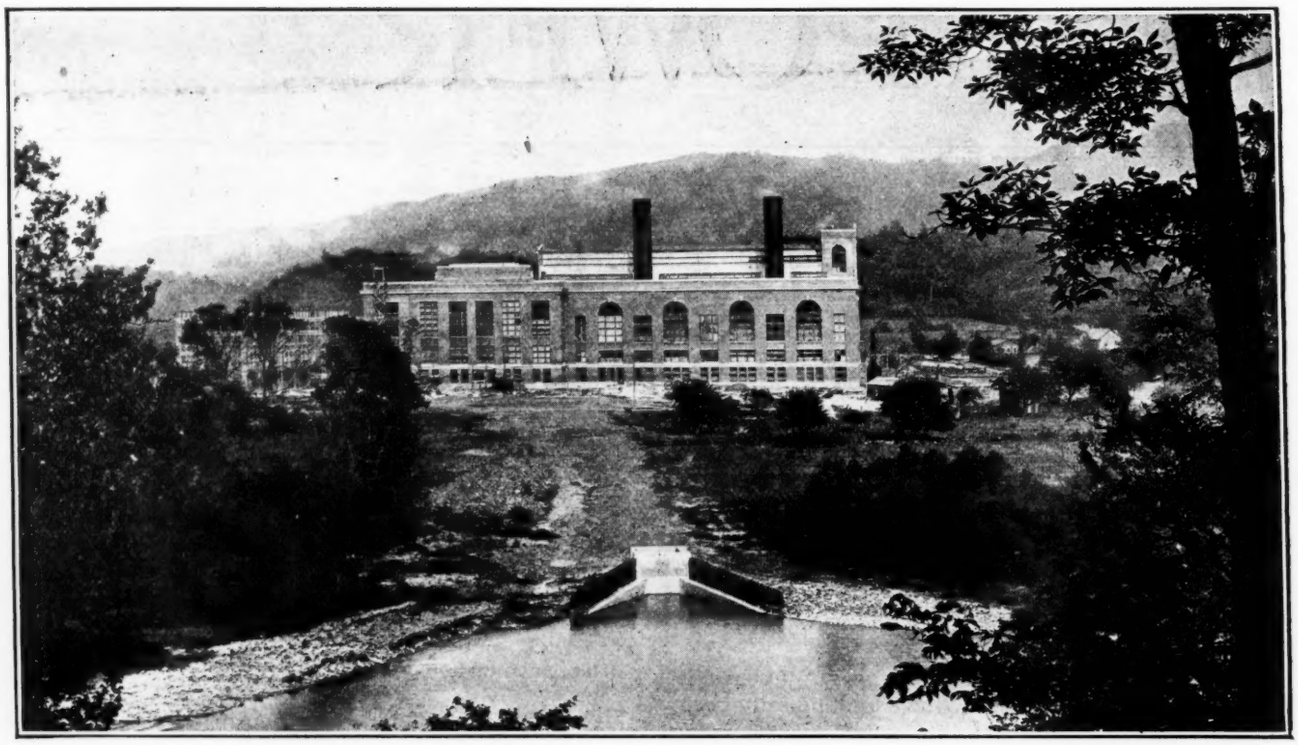
A correspondent tells of a man who has been attending an engineering school—probably of the manual-training sort giving evening instruction—for a year besides working in two power plants, who was denied a third-class license because he did not know how to roll a crown on a state road. Another of the questions in the examination had to do with the whistle signals on a steam derrick.

This information is no doubt essential for the operator of a road roller or a hoisting engineer, but its possession should not be made a requisite for the holding of a third-class license for general purposes.

Such legislation has been an advantage to its subjects because it has impelled them to study and think and has raised their average standing and qualifications. It has been a benefit to the employers of these men in giving them a class of more highly trained and efficient help to depend upon.

But it can easily be made ridiculous by lack of tact and good sense in its administration.

F. R. Low



Saxton Plant of the Penn Central Light & Power Company

Mine Mouth Station Designed for an Ultimate Capacity of 100,000 Kw.—First Section 20,000 Kw. Installed—Boilers Equipped with Economizers—House Turbine and Low-Pressure Evaporators—Load on House Turbine Automatically Controlled by Temperature of Boiler-Feed Water

BY ALFRED IDDLES
Chief Power Engineer, Day & Zimmermann, Inc., Philadelphia, Pa.

THE Superpower Survey put emphasis on the desirability of generating as much as possible of the Nation's power at mine-mouth plants. Unfortunately, the public has perhaps obtained an erroneous impression concerning this phase of the question because locations where such plants can be developed are comparatively rare. Nature did not arrange for coal and condensing water to occur side by side in any but a few favored sites. Saxton, Pa., is one such site, with conditions favorable for developing a station of 80,000 to 100,000-kw. capacity.

The Penn Central Light & Power Co. furnishes power to a large area in the central part of Pennsylvania, extending from State Center on the north nearly to the Maryland boundary on the south and from Lewistown on the east to Vintondale on the west. Prior to the completion of the first unit at Saxton the system was supplied by hydro-electric plants at Warrior Ridge on the Frankstown branch and at Hawn's Bridge on the Raystown branch of the Juniata River and by steam stations at Warrior Ridge and at Williamsburg on the Frankstown branch.

The need for additional generating capacity to serve the company's rapidly growing load brought about a study of the available plant sites throughout the region served by the system. This study directed attention to the Broad Top coal field and resulted in the selection of a site at Saxton, in the extreme northeast portion of Bedford County and about twenty-five miles southeast of Altoona. The Raystown branch of the Juniata River supplies the cooling water, and a series of coal mines on Shoup's Run offer an abundant supply of semi-bituminous coal under mine-mouth conditions. The town of Saxton is on the Huntingdon & Broad Top Mountain Railway, which joins the main line of the Pennsylvania Railroad at Huntingdon, twenty-five miles to the north.

The selection of this site and the characteristics of the system to be served, created conditions that have a direct bearing on and determined, to a great extent, the fundamental design of the station. These are:

1. A near-by supply of coal.
2. Coal cost equal to the cost at the mines plus local handling charges.
3. River conditions, due to ice and floods, which made it necessary to locate the plant at some distance from the river, to permit the passage of flood waters. The state authorities required a 1,000-ft. spillway for the

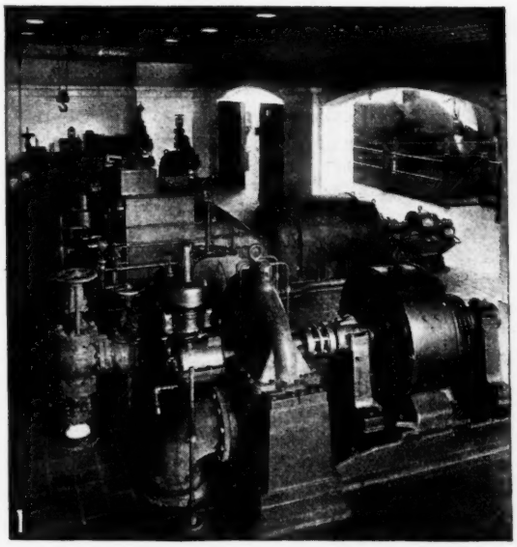


Fig. 1 — Auxiliary bay, containing turbine-driven emergency exciter, house turbine and two turbine-driven boiler-feed pumps

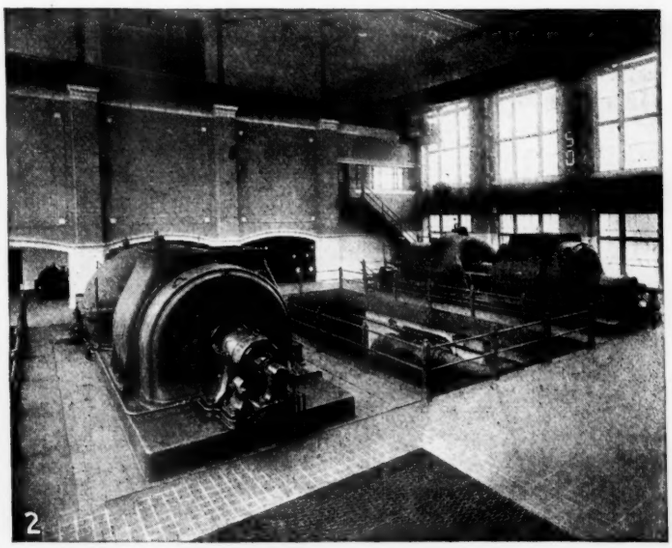


Fig. 2 — Two 10,000-kw. main generating units in the intial installation

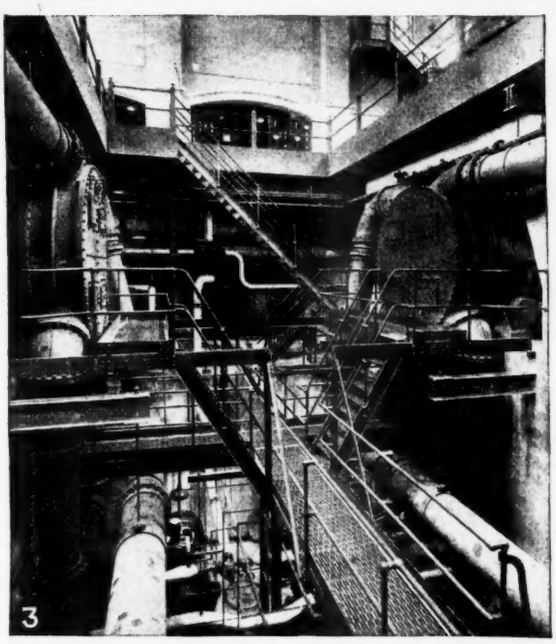


Fig. 3—Pit between the two 17,500-sq.ft. condensers. Note how well this part of the plant is lighted from turbine room

Fig. 4 — One of four 11,120-sq.ft. boilers installed. Gaye and control board for two boilers shown in the right foreground. Stokers are driven by two 4-speed squirrel-cage 5-hp. motors, which, with two gear speeds, provide 8 separate speeds

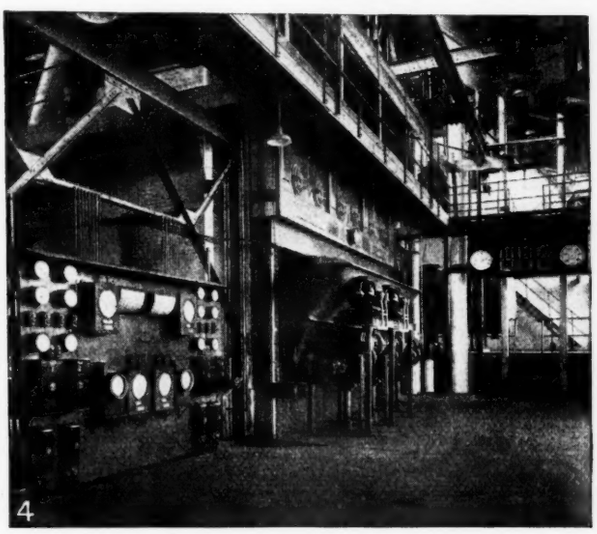
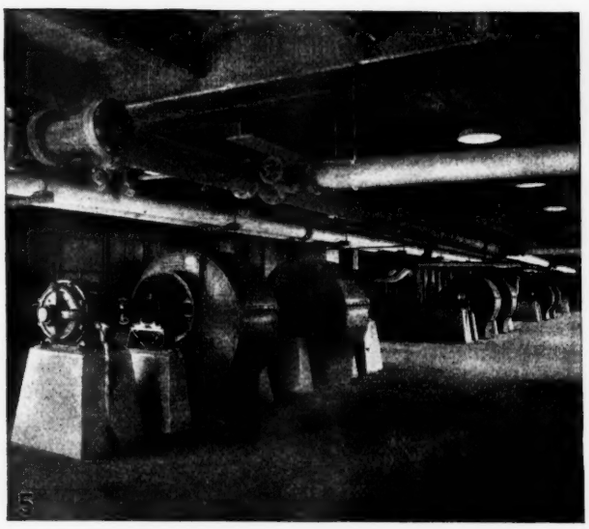


Fig. 5—Two forced-draft fans per boiler are on the mezzanine floor below boiler firing aisle. These fans are driven by 2,200-volt squirrel-cage motors



dam, which will be constructed at a later date to conserve the water supply.

4. Desirability of operation as a base-load plant with a yearly load factor of 60 per cent to 65 per cent.

5. Low ground, available for ash disposal, for a number of years and then ash removal by standard-type railway cars.

6. Distribution of most of the energy generated over four or six 110,000-volt circuits to points of tie-in with

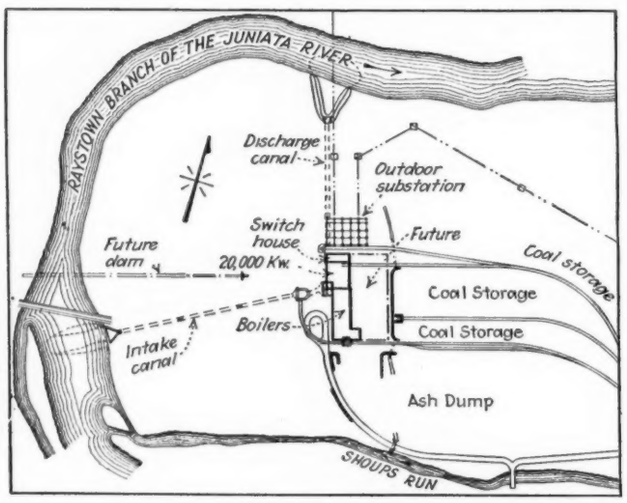


Fig. 6—Location of power house with relation to river

the present system at Summit, near Altoona, and at Lewistown, at the eastern end of the system.

7. Voltage and capacity conditions that require switching equipment suitable for operation with high-voltage transmission lines and with high rupturing capacity.

8. Feed water containing total solids amounting to 185 parts per million.

Fig. 6 shows the other general arrangement of the station in relation to the river. A variation in water level of 27 ft. had to be provided for in the construction of the condensing-water facilities because of flood conditions. The highest flood on record occurred at the time of the Johnstown flood, when the elevation of flood waters at the plant site was within two feet of natural grade, which is also present grade of the first floor.

The first section of the plant, with 20,000 kw. installed, has been provided with only a small diversion dam just below the mouth of the intake canal. With the next installation it will be desirable to construct a small permanent dam, about 10 ft. high with provisions for 4-ft. flashboards. This dam will provide capacity for storing water during the off-peak-load period, to be used during the daytime or peak-load hours.

The nearest railroad is the Dudley branch of the Huntingdon & Broad Top Mountain, which taps the coal fields on Shoup's Run. A siding of 4,000 ft. was built from this branch to the power plant. A considerable area along Shoup's Run is available for ash disposal for some years to come. When this has been filled, it will be necessary to remove ashes from the site.

The power-house building is a steel frame structure with brick walls and terra-cotta trim. Especial care has been exercised to make it architecturally attractive both outside and inside. The exterior walls are laid up with tapestry brick with thick struck joints. The inside face of the walls is of buff-colored smooth-face brick. Floors are concrete except in the turbine room, where red quarry tile has been used. Roofs are concrete with felt and asphalt waterproofing. To prevent condensation on the underside of the turbine-room roof, layers of hair felt and gypsum have been installed between the concrete and the waterproofing.

All foundations are concrete resting on rock which lies about 10 ft. below grade. Inasmuch as the maximum variation of river level is 27 ft., it has been necessary to construct the condenser pit and turbine foundations in the form of a concrete box of sufficient weight and suitable anchorage to the rock to prevent flotation.

The ash-aisle floor in the boiler house is at the same level as the natural ground at the site. A standard-gage railroad track enters the building on the ash-

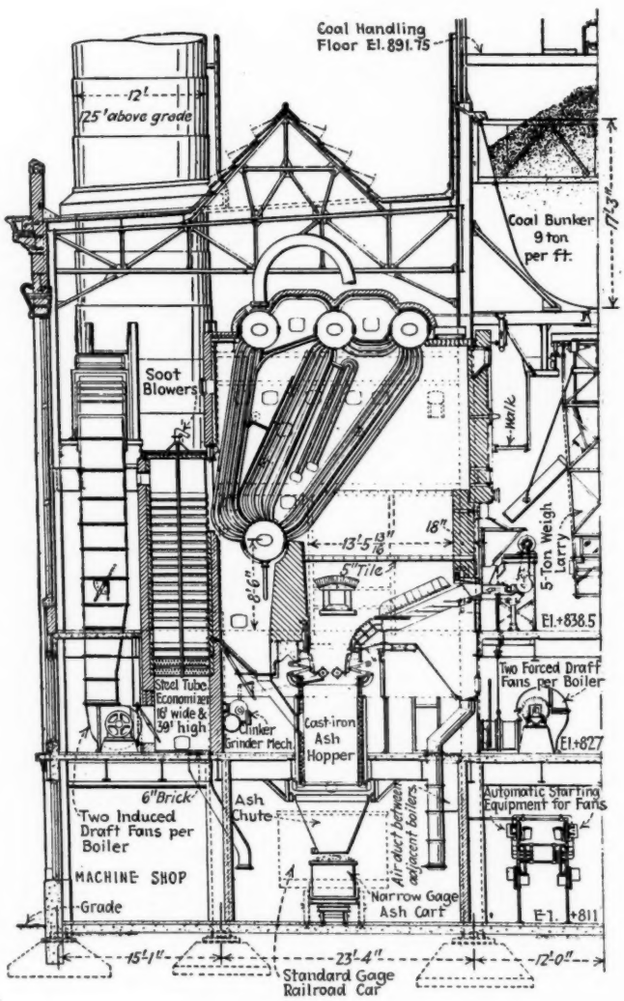


Fig. 7—Four boilers installed each of 11,120 sq.ft. of heating surface, 1,500 sq.ft. of superheater and 6,737 sq.ft. of economizer surface

room floor and also the turbine-room basement at this grade.

There are two unlined steel stacks for the four boilers, each stack 12 ft. in diameter and supported on the structural steelwork of the building. The tops of the stacks are 96 ft. above the boiler-room floor level.

The present installed turbo-generator capacity is

20,000 kw. in two units, placed transversely to the length of the turbine room. Each 10,000-kw. unit is supplied with steam by two Stirling boilers built for 300-lb. pressure. Steam is supplied to the turbine throttles at 260 lb. pressure with 225 deg. of superheat, equivalent to a total steam temperature of 634 deg. F., at 250 per cent of boiler rating. The station is laid out for three additional units of 25,000-kva. capacity each, although sufficient space has been allowed to permit of installing 30,000-kva. units if desirable. Each new unit will be served by a single row of four boilers parallel with the present row of four.

A two-pass, two-compartment surface condenser containing 17,500 sq.ft. of cooling surface of Muntz metal tubes serves each main generating unit. The condenser is supported on the concrete foundations with a corrugated-copper expansion joint and filler piece between it and the turbine exhaust nozzle. These condensers are designed to maintain an exhaust pressure of 1½ in. of mercury absolute with full load and 70 deg. F. cooling water. Each condenser is served by a duplicate circulating-water, condensate and air-pump equipment. The circulating-water pumps are installed in a pit 16 ft. below the condenser-room floor to accommodate the variation in the level of the river. There are two circulating-water intake canals so arranged that the two pumps for each condenser take their suction from separate canals. The discharge of the pumps is piped direct to the corresponding half of the condenser shell, but with a valve and bypass connection between so that either pump may be operated to supply water to the entire condenser. The valves on the pump discharge and bypass connection are motor operated and controlled from the operating gageboard on the floor above. Operated together, the circulating pumps have a capacity of 24,000 gal. per min. Except when the circulating water is warm, one pump only is normally in operation supplying 14,000 gal. per minute.

Boilers and Settings

There are four Stirling boilers, each containing 11,120 sq.ft. of heating surface and 1,500 sq.ft. of superheater surface. Each boiler is provided with a steel-tube economizer of 6,737 sq.ft. of surface (see Fig. 8). The economizers have forged-steel headers arranged for two rows of 16 tubes each. The water enters the bottom header at one end of the economizer, and the tubes are so arranged that the water flows through one horizontal bank of tubes to the header at the opposite end of the economizer, thence in the opposite direction through the next row of tubes above and so on until the top of the economizer is reached. The flue gases enter the top of the economizer and leave at the bottom, thus providing for 100 per cent counterflow between the water and flue gases.

The boilers are set with the center line of the mud drums 8 ft. 6 in. above the boiler-room floor, which gives a furnace volume of 19.26 cu.ft. per square foot of projected grate area. This equals a furnace volume of 0.34 cu.ft. per pound of coal burned at 300 per cent boiler rating and a ratio of furnace volume to heating surface of the boiler and economizer combined equal to 0.23. This furnace volume has proved entirely satisfactory for the low-volatile semi-bituminous coal supplied to this station.

The boiler settings are built of firebrick and buff-colored face brick. With the exception of the walls around the furnace itself, where the temperatures are

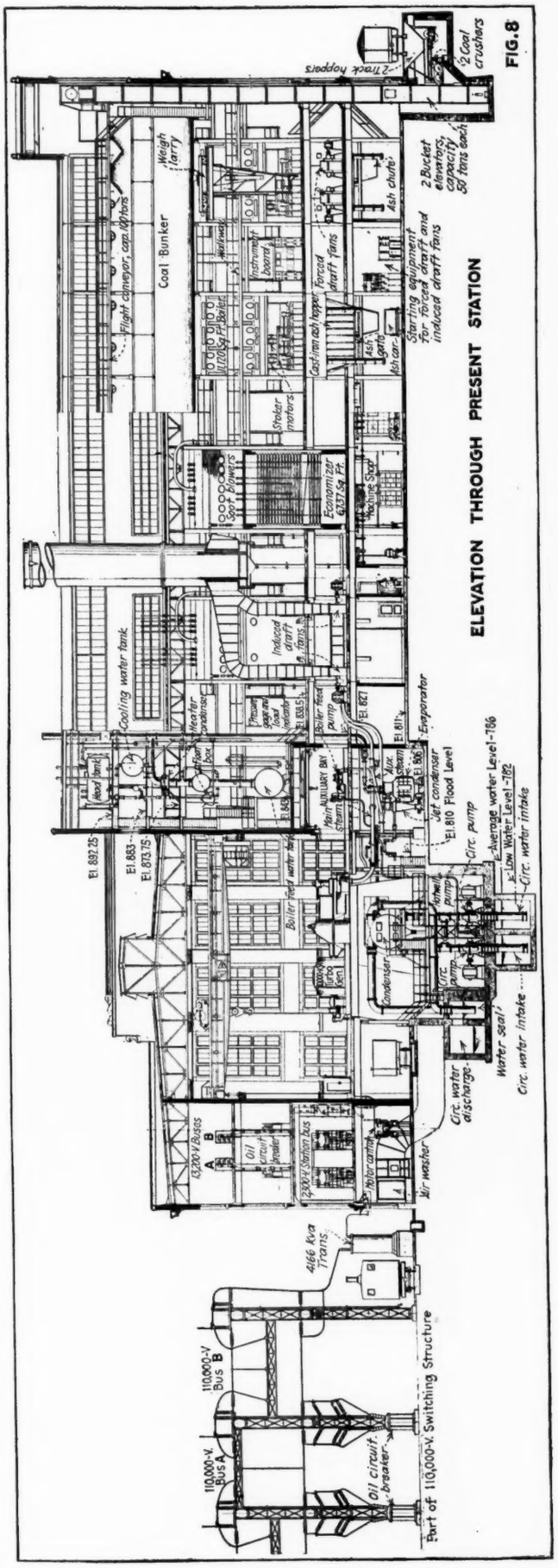


FIG. 8

high, the settings have a 4-in. layer of heat-insulating brick between the firebrick and the face brick. Expansion joints in the brickwork are provided to prevent cracking of walls as far as possible. The 13-in. firebrick lining is arranged with vertical expansion joints on 3-ft. centers to provide for horizontal expansion. Vertical expansion is provided for by leaving a ¼-in. space under the headers back of the line of stretchers which occur every 12 in. in the height of the wall. In addition an expansion joint is provided along the entire wall at the top. Expansion joints packed with asbestos rope are provided at the corners where the front and side walls meet to provide for the expansion of the outside walls. One of the boiler settings was laid up without the vertical expansion joints in order that this setting might be compared with the other settings to determine the effectiveness of these vertical expansion joints.

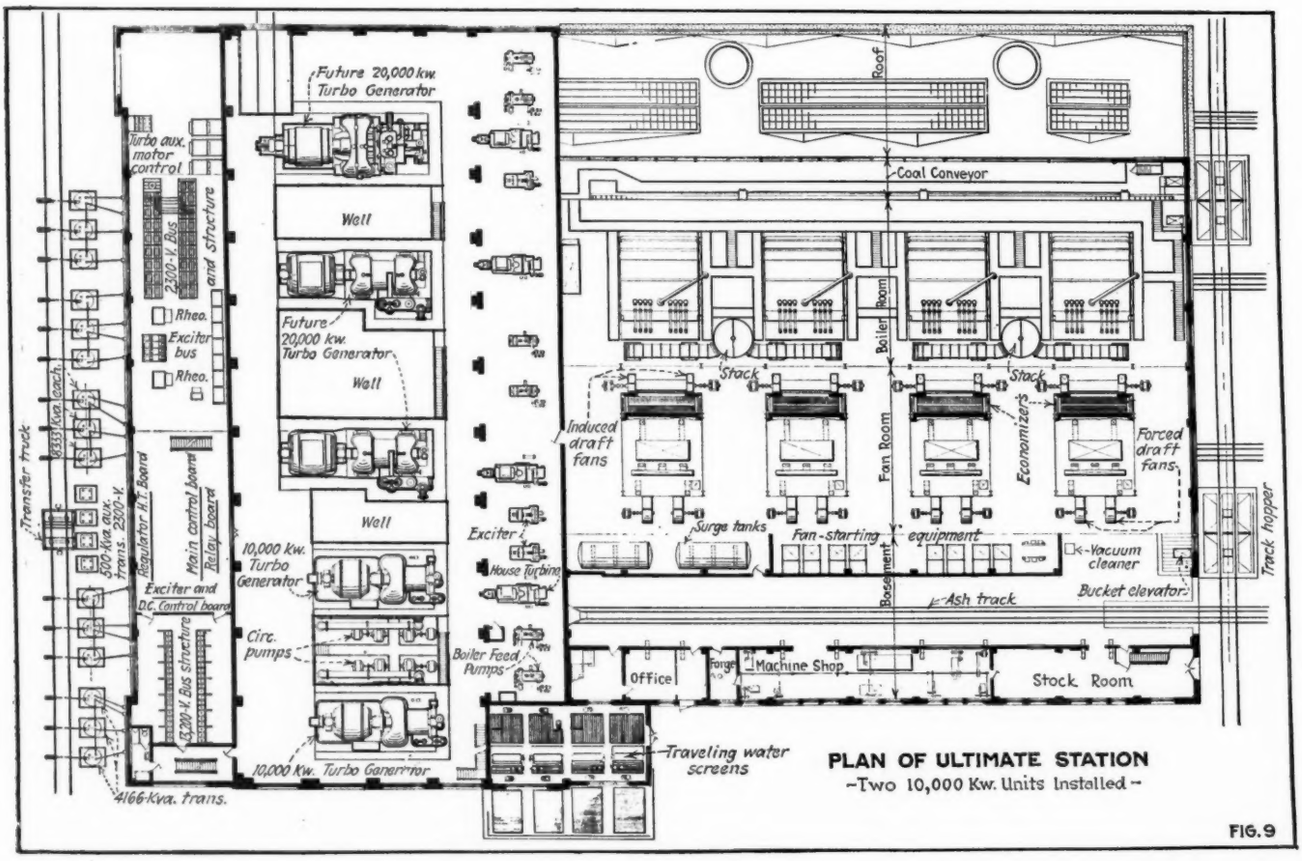
Stokers of the underfeed type are used with eleven retorts per boiler and 27 tuyeres per retort. This totals 191 sq.ft. of projected grate area per boiler, and the stokers are designed to burn a maximum of 70 lb. of coal per square foot per hour. Each stoker is equipped with a double-roll clinker grinder split in the middle and driven from both sides of the boiler by two-speed, pole-changing, induction motors. The stokers are provided with duplicate motor drive with one motor normally in operation. The motors are mounted on structural steelwork above the stoker drive shaft, as shown in Fig. 4. Each motor is a four-speed, pole-changing, semi-inclosed, constant-torque induction motor. The four speeds on the motor, together with the two speeds in the stoker gear boxes, provide eight separate speeds for operation of the stoker. This variation in speed has proved to be ample for the requirements.

Coal is brought to the plant from the near-by mines in standard hopper-bottom railway cars and discharged into a double-track hopper at the end of the boiler room. Duplicate equipment of double-roll crushers, feeders and bucket elevators, each of 50 tons per hour capacity, has been provided. The bucket elevators discharge the coal onto a flight conveyor of 100 tons per hour capacity, which delivers the coal into a steel, suspension-type bunker of 1,700-tons capacity, located over the firing aisle in front of and parallel with the boilers.

A 5-ton weigh larry operates under the suspension bunker and distributes the coal to the stoker hoppers. The operating platform of this weigh larry is 3 ft. 6 in. above the boiler-room floor, just enough to permit of observation of the coal in the stoker hoppers and yet conveniently near the operating floor. This makes it convenient for the operator to perform other functions in connection with the boiler operation.

A cast-iron, brick-lined ash hopper is provided under each boiler, capable of storing 36 hours' supply. The hoppers discharge the ashes into industrial cars which are hauled by a gasoline locomotive to a near-by dump. Provision is made for running standard-gage railway cars under the hoppers when it becomes necessary to remove the ashes from the property.

Each boiler is served by two turbo-vane forced-draft and two multi-vane induced-draft fans, each driven by a constant-speed induction motor. These fans are on the mezzanine just below the boiler-operating floor. One forced- and one induced-draft fan will operate a



PLAN OF ULTIMATE STATION
–Two 10,000 Kw. Units Installed–

FIG. 9

boiler at a capacity up to about 200 per cent of rating. For higher ratings the other two fans are operated. The capacity of the induced-draft fans is partly regulated by a butterfly damper in the discharge of each fan, and the control of the draft over the fire is regulated by a butterfly damper between the exit from the economizer and the suction side of these fans. This damper is under control of a master regulator, which is actuated by changes in the steam pressure in the main steam header. With a change in the steam pressure, the draft over the fire is increased or decreased as required by the master regulator, and this change in the draft over the fire actuates the controller which operates the dampers between the forced-draft fan and the stoker windbox.

A steel duct with 85 sq.ft. cross-section area has been installed to convey air from the top of the boiler room and from the top of the turbine room to the fan room. This makes it possible to supply warm air for the forced-draft fans from either the turbine room or the boiler room or both. The generator air discharges upward into the turbine room, and normally a considerable quantity of this warm air is supplied through this duct to the forced-draft fans.

All high-pressure steam piping has been laid out with the minimum number of joints and with the shortest distances possible. All joints are of the Sargol welded type. Double-length pipe has been used wherever possible to eliminate flanged joints. The flanges on all high-pressure piping are forged steel, built to the American standard for 250-lb. pressure, except that the bolts and bolt holes are $\frac{1}{8}$ in. larger than the American standard. All flange bolts for high-pressure steam are made of heat-treated steel of high-tensile strength. The

Fig. 10—Gage board on turbine-room floor

auxiliary steam header receives steam from either of the two main steam headers and is so sectionalized that any portion can be taken out of service for repairs without shutting down the entire plant.

All motors for circulating pumps, induced- and forced-draft fans, house service pumps and air compressors are 2,200-volt with automatic push-button control. All smaller motors, are 440-volt with hand control. The motors driving the coal-handling system are 440-volt with automatic push-button control.

All auxiliaries are motor driven with the exception of the boiler-feed pumps, the spare exciter, the spare condensate pumps and the spare house-service pump. A 150-kw. turbo-exciter is provided for emergency operation. Normally, the excitation current is provided by shaft-end exciters on the main units. A 750-kw. house

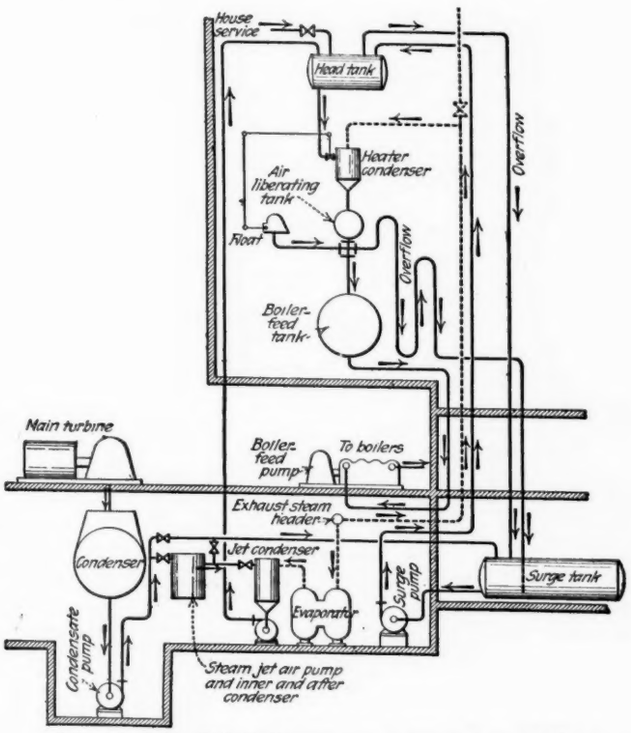


Fig. 11—Simplified diagram of feed-water piping

turbo-generator supplies part of the power to drive the station auxiliaries and provides for proper heat balance.

The house turbine is of a size sufficient to supply the energy for the auxiliary motors which are essential to the operation of the plant. In normal operation these essential motors (one circulating-pump motor per turbine, one induced-draft fan for each boiler, etc.) are connected to the house-turbine bus and all motors not essential to the continuous operation of the plant are connected to the station auxiliary bus. In the event of trouble which interferes with the supply of power from the main station bus, the house turbine and the auxiliary motors connected to it are isolated automatically, which leaves the house turbine supplying the essential auxiliaries.

The load on the house turbine is automatically controlled so as to furnish sufficient exhaust steam to maintain the boiler-feed water at a temperature of approximately 205 deg. F. This automatic adjustment is obtained by means of a thermostat located in the discharge from the feed-water heater. This thermostat operates through a relay to control the synchronizing motor on the house turbine, and through it the load carried by this machine. The whole scheme is so arranged that manual control from both the turbine-room floor and the electrical control room can be utilized in case of failure of the automatic control or in case of wide fluctuations in the load.

The exhaust steam from the boiler-feed pumps and

the house turbine passes to the barometric type of heater condenser, where it is condensed by the condensate from the main turbine, and to the evaporators when in operation. The condensate pumps serving the main condensers discharge through the intercooler and after-condenser of the air pumps, absorbing the heat in the exhaust of these pumps. The condensate then passes to the surge tanks and thence to the jet condenser serving the evaporator. The removal pump on the jet condenser forces the condensate and makeup water to the head tank, located above the heater condenser.

The evaporators are of the two-effect flash type, arranged with hydraulically operated valves so that either effect may be first in the heat cycle. A reversal of the two effects is designed to cause a sufficient expansion and contraction of the coils to crack therefrom any scale that may be deposited from the raw water. The evaporators are supplied with raw water from the house-service system and with steam at approximately atmospheric pressure from the exhaust of the house-turbine and boiler-feed pumps. The condensate from the main units is used as the injection water in the evaporator jet condenser, resulting in a normal vacuum of about 24 to 25 in. of mercury.

The flow of water from the head tank to the heater condenser is controlled by a float-operated valve which maintains a constant water level in the air liberating tank. In this tank, which is in reality a part of the boiler-feed tank, the condensate, heated to a temperature of 205 to 210 deg. F., is divided into a large number of small sprays. In this finely divided state and with a temperature near the boiling point, the air in the water is removed by the steam-jet air pump attached to the tank.

Temporary excess of condensate in the head tank or the air-liberated tank overflows to the surge tanks, from which it is pumped again to the head tank when the water falls below a predetermined level therein.

A centrifugal purifier is provided for the turbine lubricating oil, and another unit for the transformer and switch oil. In each case steel tanks are arranged to receive the dirty oil and so placed that it flows by gravity through the purifier and thence into a clean tank. Pumps are provided for forcing the clean oil either through the purifier again or direct to the turbine or the transformers as the case may be. The arrangement for turbine oil is such that the continuous bypass system of purification or the batch system can be used.

The main units may be connected to either one of a duplicate set of 13,200-volt buses. Outgoing feeders for supply of local coal mining load may be supplied from either of these buses. Power for long-distance transmission is fed from this duplicate bus system through two banks of single-phase water-cooled transformers which raise the potential to 45,000 volts. The ultimate transmission voltage will be 110,000. Outside the switchhouse is located a high-tension switching structure equipped with duplicate buses, which, together with the low-tension duplicate buses, form a flexible switching arrangement.

This station was designed and constructed by Day & Zimmerman, Inc., Philadelphia, Pa., in co-operation with the engineers of the Penn Central Light & Power Co., Altoona, Pennsylvania.

DATA ON PRINCIPAL EQUIPMENT IN THE SAXTON STATION OF THE PENN CENTRAL LIGHT & POWER COMPANY

GENERAL

Location of plant	Saxton, Pa.
Character of load	Power and lighting
Capacity, ultimate, kw	80,000
Capacity, present, kw	20,000
Turbine room, ultimate (5 units)	98x225 ft.
Turbine room, present (2 units)	98x84 ft.
Boiler room, ultimate (16 units)	187x200 ft.
Boiler room, present (4 units)	187x62 ft.
Switchhouse, ultimate	30x225 ft.
Switchhouse, present	30x84 ft.
Area of ultimate station, sq.ft. per kw	0.83

BOILERS

Manufacturers	Babcock & Wilcox
Type	Stirling
Number, present	4
Number, ultimate	16
Boiler pressure, gage	300 lb.
Water-heating surface, each	11,120 sq.ft.
Width of furnace	19 ft. 9 in.
Grate area, projected, per boiler	191 sq.ft.
Clinker-grinder area, projected	67 sq.ft.
Total furnace area, projected	258 sq.ft.
Ratio water-heating surface to grate area	58 : 1
Water-heating surface per kw. installed	2.22
Heating surface per sq.ft. boiler-room floor area (ultimate)	4.76
Furnace volume	3,680 cu.ft.
Ratio furnace volume to water-heating surface	1 : 3
Ratio furnace volume to projected grate area	19:1
Manufacturer of economizers	Babcock & Wilcox
Type	Duratex
Location	Rear of boilers
Heating surface, each, sq.ft	6,737
Ratio economizer heating surface to boiler-heating surface	1 : 1.65
Manufacturer of superheaters	Babcock & Wilcox
Type	Convection
Location	Between 1st and 2nd pass
Superheating surface per boiler, sq.ft	1,500
Ratio superheating to boiler heating surface	1 : 7.41
Steam temperature at 300 per cent rating, deg. F	656
Corresponding superheat, deg. F	240
Steam outlet from superheaters	One 8 in.

STOKERS

Manufacturer	American Engineering Co.
Type	Taylor, CH-25
Effective width	19 ft. 1⅞ in.
Effective depth	13 ft. 5⅞ in.
Projected grate area	191 sq.ft.
Coal burned per sq.ft. of grate (max.rating)	70 lb. per hr.
Stoker motors (each stoker)	Two 4-speed squirrel cage 5 hp.
Clinker grinders, type	Two-roll
Clinker grinders, drive	Two 2-speed, 2½ hp. squirrel-cage motors

STOKER PERFORMANCE

Boiler Rating, Per Cent	Combined Efficiency Boiler, Economizer and Stoker, Per Cent	Flue-Gas Temp. Deg. F.
100	85	350
150	85	360
200	82	370
250	79	385
300	76	400
350	73	420

COAL

Kind	Bituminous run of mine
Region	Broad Top, Pa.
Proximate analysis:	
Fixed carbon, per cent	69
Volatile matter, per cent	19
Ash, per cent	10
Moisture, per cent	2
Total	100
Sulphur, per cent	2.27
Heat value, B.t.u.	14,000
Ash, fusing temperature, deg. F	2,400 to 3,000

CHIMNEYS

Built by	Connery & Co.
Type	Self-supporting steel
Number, present	2
Number, ultimate	8
Height above boiler-room floor, ft	96
Diameter at top, ft	12
Chimney supported on	Structural steel

FORCED AND INDUCED DRAFT FANS

Manufacturer	B. F. Sturtevant Co.
8 Forced draft (2 per boiler)	No. 80, design 4
Capacity cu.ft. per min. at 6 in. of water static pressure, each	30,000

DATA ON PRINCIPAL EQUIPMENT IN THE SAXTON STATION (Concluded)

Drive	50-hp. 1,800-r.p.m. 2,200-volt motor
8 Induced draft (2 per boiler)	No. 7½ multivane, design 3
Capacity, cu.ft. per min. at 7 in. of water static pressure, each	42,000
Drive	100-hp. 1,200-r.p.m., 2,200-volt motor

COAL-HANDLING EQUIPMENT

Manufacturer	Link-Belt Co.
2 Crushers, two-roll, capacity each	50 tons per hr.
2 Bucket elevators, capacity each	50 tons per hr.
1 Flight conveyor, capacity	100 tons per hr.
1 Weigh larry, capacity	5 tons
Bunker	Steel suspension type
Built by	Fort Pitt Bridge Co.
Capacity	1,700 tons
System will be duplicated for ultimate cap.	
Coal handling for yard storage	Locomotive crane and grab bkt.
Locomotive crane, make	Ohio Locomotive Crane Co.

ASH HANDLING

Pneumatic ash gates, 2 per boiler	Allen-Sherman-Hoff Co.
Gasoline locomotives for temp. ash disposal	Geo. D. Whitcomb
Two-ton ash cars for temporary ash disposal	Eastern Car & Foundry Co.

MAIN TURBO-GENERATORS

Manufacturer	Westinghouse Elec. & Mfg. Co.
Number, present	Two 10,000-kw.
Number additional	Three 20,000-kw.
Speed	1,800 r.p.m.
Generators	3-phase, 60-cycle, 13,200-volt
Ventilating air per unit	40,000 cu.ft. per min.
Air washers	Carrier Air Conditioning Co.
Exciters	250 volts
Direct connected	75 kw.
Turbine driven, spare	150 kw.
Turbine guaranteed performance. Steam at throttle 250 lb., 625 deg. F. and 28.5 in vacuum.	
Kw. load — Steam per Kw.-Hr., Lb.	
5,000	12.65
7,500	11.75
10,000	11.5
12,500	11.5

HOUSE TURBINE

Manufacturer	Westinghouse Elec. & Mfg. Co.
Type	Non-condensing
Capacity	750 kw.
Speed	3,600 r.p.m.

CONDENSERS

Manufacturer	C. H. Wheeler Mfg. Co.
Type	Surface, 2 compartment
Tube surface, each, sq.ft	17,500
Support	Solid upon foundation
Expansion joints	Copper
Expansion joints supplied by	E. B. Badger & Sons Co.

CIRCULATING PUMPS

Manufacturer	C. H. Wheeler Mfg. Co.
Number	2 per condenser
Drive	150-hp., 2,300-volt, squirrel cage motors
Capacity, each, gal. per min	12,000
Speed	600 r.p.m.

CONDENSATE PUMPS

Manufacturer	C. H. Wheeler Mfg. Co.
Number	2 per condenser, 1 turbine driven, 1 motor driven
Capacity, each, gal per min	350

RADOJET AIR PUMPS

Manufacturer	C. H. Wheeler Mfg. Co.
Number	Two per condenser
Inter and after condensers	Surface type
Capacity, each at 2 in. absolute	101 lb. per hr.

BOILER-FEED PUMPS

Manufacturer	De Laval Steam Turbine Co.
Number	2
Type	Turbine driven, centrifugal
Capacity, each	650 gal. per min. at 320 lb.
Stages	4

EVAPORATORS

Manufacturer	Wheeler Condenser & Eng. Co
Type	Two effect, low heat level
Capacity, lb. per hr	13,000

MISCELLANEOUS EQUIPMENT

House service pumps	De Laval Steam Turbine Co.
Surge pumps	De Laval Steam Turbine Co.
Traveling crane (50 ton)	Bedford Foundry & Mach. Co.
Auxiliary crane (5 ton)	Maris Co.
Oil purifiers, centrifugal	De Laval Separator Co.
Air compressors	Bury Compressor Co.
Venturi meters	Simplex Valve & Meter Co.
Feed-water regulators, copes	Northern Equipment Co.
Non-return valves	Edwards Valve Co.
Combustion and damper control	Hagan Corp.
Soot blowers	Diamond Power Specialty Co.
Boiler meters	Bailey Meter Co.
Traveling screens	Link Belt Co.
Strainers	Elliott Co.
Safety valves	Consolidated Safety Valve Co.
Blowoff valves and cocks	Yarnall-Waring Co.
Fire brick and clay	Harbison-Walker Refractories Co.
Bernitz perforated furnace blocks	Bernitz Furnace Appliance Co.
Sil-O-Cel brick	Celite Products Co.
Bonding tile	Babcock & Wilcox Co.
Smoke flues and forced draft ducts	Connery & Co.
Condenser tubes	Scovill Mfg. Co.
Circulating-water valves	Pittsburgh Valve Foundry & Construction Co.
Atmospheric relief valves	C. H. Wheeler Mfg. Co.
Operating and control mechanism for motor operated valves	Payne Dean, Ltd.
Recording and indicating gages and thermometers, Schaeffer & Budenburg Mfg. Co., Bailey Meter Co., The Bristol Co., Brown Instrument Co., Taylor Instrument Co.	
Gratings for walkways	Irving Iron Works
Surge and storage tanks	Sharpsville Boiler Works
Pipe covering, (85% magnesia)	Philip Carey Co.
Steel sash and sash operators	Truscon Steel Co.
Skylights	H. H. Robertson Co.
Building contractor	Foundation Co. of America
Structural-steel contractor	Fort Pitt Bridge Co.
Piping contractor	Pittsburgh Valve Foundry & Construction Co.
Station designed and constructed by	Day & Zimmermann, Inc.

All important electrical equipment in power house supplied by Westinghouse Electric & Manufacturing Co.

Keeping Solid Impurities Out of the Air-Compressor Intake

By William V. Fitzgerald

Compressing air is an operation that is carried on in so many industries that it is hard to find engine rooms of any sort not employing one or more compressors. The smaller types, especially portable gasoline or motor-driven compressors, are subjected to various conditions of operation which cannot readily be foreseen, and the consequent difficulties attending cannot be guarded against.

For instance, a portable gasoline-engine driven unit was operating in suburban New York during the excavation for a huge apartment. The compressor was supplying air to a number of rock drills while the thermometer stood well below the freezing point. Perhaps the same unit will be working in the tropical heat of July or August within a short time, but with no change in the lubricant, cooling-water supply or other variable factors. The best operation cannot be hoped for under such conditions, little attention being paid to the compressor as long as it supplies enough air to keep five of six drills going constantly.

The large power plant, however, has quite a different problem with an exceptionally good opportunity to secure the best results.

In analyzing the troubles in air-compressor operation, a single cause for all is frequently found. Even when explosions occur in the compressor system, it is reasonable to trace back through the various secondary causes to the one fundamental—impurities in the intake air.

No one factor in compressor operation is so basic and so far-reaching in its effect as impurities in the air that it handles. Consider first, that the air contains only minor impurities, such as would be found in a room of an average dwelling. In such a room the rapidity with which dust settles on a polished table is remarkable, even in the absence of air agitation. A compressor, handling every minute many times the volume of air in a single room, receives a proportionate amount of dust, which over a period of time becomes quite a factor.

Assuming the air to contain only an average percentage of solid impurities, it is obvious that every stroke of the piston draws into the cylinder a certain quantity of solid material. This tends to attach itself to some

portion of the cylinder, much clinging to the oil film, wherever present and exposed to the air. The quantity of oil required to lubricate the compressor is decreased or increased in proportion to the greater or less amount of impurities deposited on the cylinder walls. The tendency of the greater oil film is to collect impurities more easily and so aggravate the trouble. If the oil feed is reduced, there is the liability of insufficient lubrication to offset the effect of the impurities.

With splash-lubricated air compressors there is no doubt that much of this mixutre of oil and solids passes by the piston into the crankcase. With the double-acting compressor, however, the mixture is likely to remain in the cylinder or on the piston, on the valves or in the valve passages, where it forms a gummy, sludgy deposit, which bakes hard under continued operation.

These deposits are often termed "carbon deposits," but it is open to question as to just what the correct name should be. It is certainly not carbon in the sense of its being the unburned products of combustion. It is not a breaking down of the lubricating oil, provided a

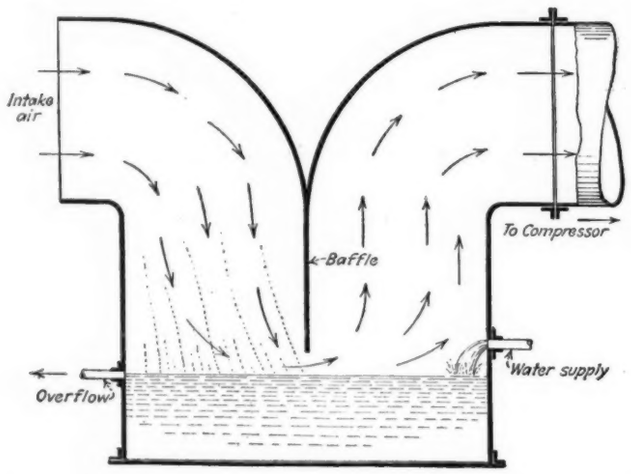


Fig. 1—Baffle throws solid particles to water surface

reasonably good grade is used, nor is it the direct result of an oil of too heavy a body. It may come from the use of a heavy oil by reason of its aptitude to collect impurities.

There may be cases when the compressor cooling water will show normal operation although the temperature in the cylinder may be much higher than indicated. This again, may be due to the dirt in the intake air forming a deposit on the cylinder head and preventing a proper heat transfer to the cooling water. Abnormal temperature will have its effect upon the lubricating oil, tending to break it down or vaporize it. This, in turn, necessitates giving more oil to the compressor.

Deposits on the cylinder head and piston head usually result in imperfect seating of the valves. The air, leaking past the valves through the restricted openings, becomes excessively heated owing to the friction. A lowering of the compressor output results, and there is also a danger of more serious trouble.

Intake air, then, is a vital factor in compressor operation and maintenance. No one can expect good results if this factor is left to chance or carelessly treated. The compressor air supply should come from only the cleanest part of the plant, and care should be taken to see that the intake is not located where the wind blowing dust or ashes or particles of sand will contaminate the air. A device should protect the air at all times such as some sort of strainer to filter out the solids and gritty substances which become entrained.

An arrangement such as the one shown herewith, will serve the purpose admirably. This consists of a baffle plate fixed in the intake to the compressor, which deflects the air downward. Below the baffle plate is a supply of water. The air coming into the intake line is deflected downward by the baffle, the solid particles striking the water and lodging therein. The air, changing its direction upward, is freed of the particles and passes on to the compressor.

A necessary feature of this air filter is that the surface of the water below the baffle plate be kept clean. For this purpose a water inlet and overflow pipe can be introduced. By running a small amount of water constantly, a surface of fresh, clean water is maintained, which will readily absorb the solid impurities impinging upon it. The distance between the baffle plates and the water level may also be decreased, making the change in the direction of air travel more abrupt and thereby increasing the effectiveness of the device.

Proper care of the intake air will effectually eliminate much of the worry and anxiety of compressor operation. It will reduce the attention required for maintaining the compressor at normal efficiency as well as the oil feed. Continuous efficiency of the unit will be maintained by keeping impurities out of the compressor system, rather than periodic efficiency by taking out only the impurities that are easily prevented from entering.

Moisture Loss in Benson Test

A reader has called attention to a misstatement in the editorial, "Thoughts on the Benson Test," in the March 18 issue. It was there stated that a flue temperature of 110 deg. F. would condense practically all the moisture in the combustion products (from fuel oil) and thus practically eliminate the heat loss due to moisture. As a matter of fact (assuming 30 per cent excess air) most of the moisture would remain uncondensed even at 110 deg.

A study of the amount of water that can be carried by saturated flue gases of various temperatures shows that, of approximately 1.20 lb. of moisture in the flue gases from the combustion of one pound of fuel oil, only about 0.2 lb. would condense at this temperature, the remaining 1 lb. continuing in the vapor form. This represents a heat loss of about 5 per cent, which would lower the estimated efficiency from 95 per cent to about 90 per cent.

Some idea of the tremendous activity in the power-plant field may be gained from the report that a single manufacurer of steam turbines now has in the shop 58 turbines ranging in capacity from 20,000 to 60,000 kw., the average being about 35,000 kw. Assuming the correctness of these figures, the total capacity being manufactured in this one plant is over 2,000,000 kw. It should be noted that this does not includes turbines under 20,000 kw. capacity.

Reduction gears for early steam turbines were made of bronze. High-carbon steel, however, which was later substituted, has proved to be much better.

Checking Field-Coil Connections on Direct-Current Machines

By A. C. ROE
Repair Superintendent, Detroit Service Department, Westinghouse Electric & Manufacturing Company

IN MODERN direct-current generators and motors the field construction is of the salient-pole type, Fig. 1, adjacent coils being connected together in such a way as to produce alternate north and south poles. In the non-interpole types of machines the terminals are usually brought out on opposite sides of the coils

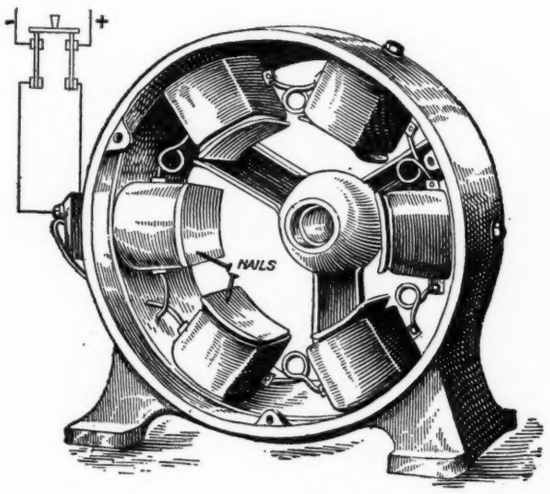


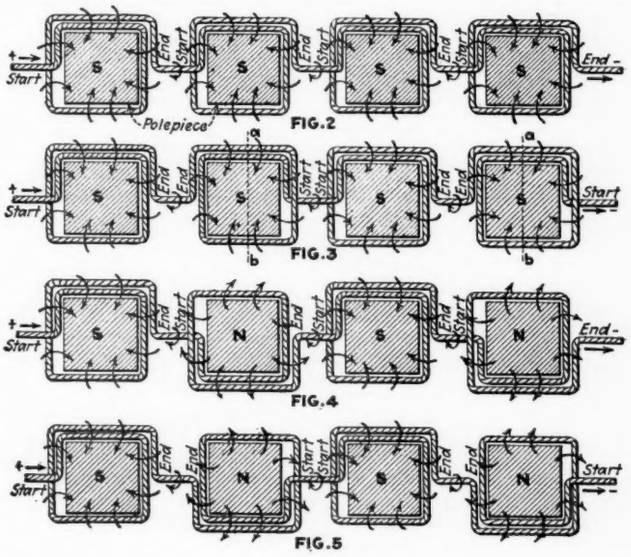
Fig. 1—Testing polarity of field coils with two nails

and the connections made between them as in Fig. 1. To obtain the correct polarity, it will be necessary that the coils be connected so that the current flows in one coil in one direction and in the adjacent coil in the opposite direction. How this may be accomplished will depend upon the type of coils.

Where the coils have the leads brought out on opposite sides and may be placed on the polepieces with either end next the frame, Fig. 2 to 5 show four different ways the coils may be grouped, two of which give wrong polarity and the other two are correct. Fig. 2 shows four coils placed in the same position so that the ending lead of one coil can be connected to the starting lead of the other coil. In this case the current flows through all coils in the same direction, therefore they have the same polarity, which is wrong for the polepieces of a motor or generator. It is also possible to obtain the same polarity in the polepieces by connecting the ending leads or the starting leads together as indicated in Fig. 3. In this case coils 2 and 4 counting from the left, Fig. 2, have been turned through 180 deg. about the axis *ab*, which brings the starting lead on the right and underneath. This is equivalent to reversing the coil on the polepieces and crossing the connections. In other words, there have been two reversals, which results in producing the same polarity for the two connections, Figs. 2 and 3. In both cases the direction of the magnetic field set up by the current is indicated by the curved arrows.

Figs. 4 and 5 show the coils connected to give the correct polarity; that is, alternate north and south poles. In Fig. 4 the connections are the same as in Fig. 2, but coils 2 and 4, counting from the left, have been reversed on the polepieces. This allows connecting the ending lead of one coil to the starting lead of the other and obtaining opposite polarity in adjacent coils. In Fig. 5 like terminals are connected together, but alternate north and south poles are produced. This has been accomplished by putting the coils on all the polepieces in the same way, but turning every other coil through 180 deg. around its polepiece. From the foregoing it is evident that where the field coils are symmetrical in shape, there are two ways that they may be placed on the polepieces to give the correct polarity and have the connections come between the coils. There is no advantage of one arrangement over the other, and where there are no marks on the coils to indicate the different leads, the results of tests must be relied upon entirely to obtain the correct polarity of the polepieces, which may give a combination of the two methods of grouping the coils.

In interpole machines the connections cannot be made conveniently between the field coils. In such machines the coils may be turned through 90 deg. from what they would be in the non-interpole type and the connections made at each end of the machine. This grouping is indicated in Figs. 6 and 7. These figures

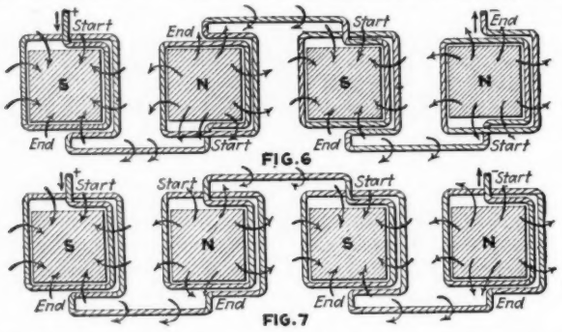


Figs. 2 to 5—Wrong and correct connections of field coils where connections are made between the coils

show the same arrangement of coils as in Figs. 4 and 5 respectively, but turned 90 deg. on the polepieces so as to make the connections on the sides.

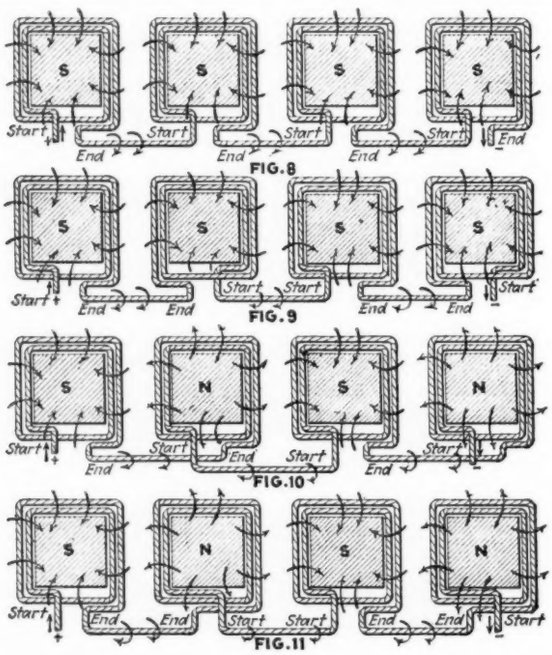
Certain classes of motors are designed so compactly that there is not sufficient room for the field connections in the back end of the frame, so that they

all have to be made at the commutator end. In such cases both coil terminals are brought out on the same side of the coil as in Figs. 8 to 11. If the leads are brought out alike on all coils, as in Figs. 8 to 10, there is only one way that the coils can be connected to give the correct polarity; namely, that shown in Fig. 10. With this connection the leads must be crossed on every other



Figs. 6 and 7—Correct connections of field coils where connections are made at opposite ends of machine's frame

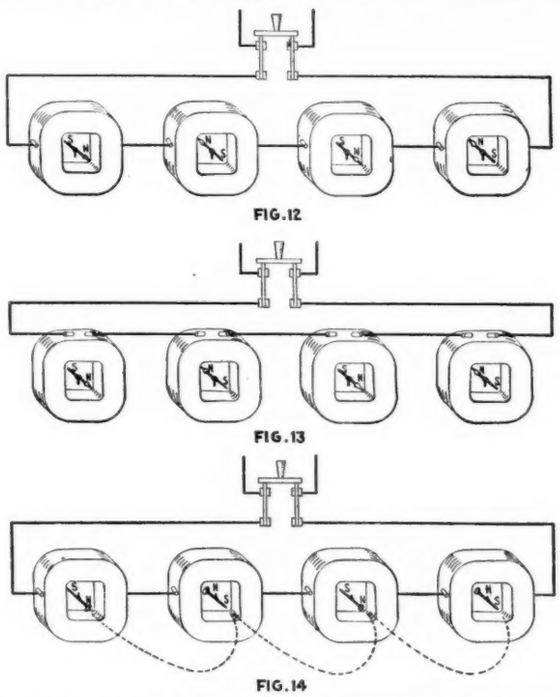
coil. To overcome this difficulty, in some cases half of the coils are made up with the leads crossed on the inside of the coil, in which case the connections are made as in Fig. 11. Where the leads cross inside the coil it is known as a closed type, and when they do not cross the coil is said to be an open type. Sometimes the open-type coils are tagged *O* and the close



Figs. 8 to 11—Wrong and correct connections of field coils when the two leads are brought out on the same side of each coil

type marked *X* to distinguish one from the other. In the different types of coils shown, only 1½ or 2 turns have been used, to simplify the connections. However, they show the principles involved as completely as if many turns were used, as is the case in the shunt coils of all machines. All the different methods of bringing the leads out on the coils have not been shown, but an understanding of those given will make it a simple matter for the reader to deal with the others when confronted with them. When checking the field connections, which are all made on one side of the coils, before taking a machine apart, if the coil leads cross at every other pole, the coils are all of the same type. If the leads do not cross at any pole, then the circuit contains open and crossed coils, which should be put back in proper order or the connections cannot be made to give the correct polarity without crossing leads at some of the coils.

If there is any doubt about the connection of field coils before they are assembled on the polepieces, it is best to make a test for the polarity of the coils before assembling. This is done by connecting the coils in series as they would normally be in the machine and



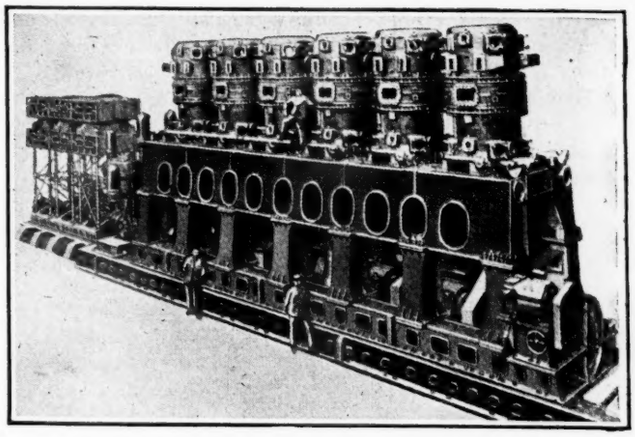
Figs. 12 to 14—Method of testing polarity of field coils before they are put into the machine

then connect them to a source of electric current, as in Figs. 12 and 13, then with a compass test the polarity of the coils. After the correct arrangement has been obtained, they can be assembled in the machine. If a compass is not available to test the coils with, they may be tested with a nail balanced in the end of a string, as in Fig. 14. The dotted lines indicate the direction in which to move the nail from one coil to the other so as to allow it to turn freely. After the nail is magnetized in one coil, care must be exercised not to reverse its polarity in the adjacent coil or a wrong indication may be obtained. After the coils have been assembled in the machine, they should be energized and the polarity of the field poles tested with a compass before putting the armature in place and completing assembling the machine. If a compass is not available to make the test with, two nails may be used. Place the points of the nails on adjacent polepieces, then bring their heads together as in Fig. 1. If they attract, the poles are correct polarity, since unlike poles attract. On the other hand, if the nails repel each other, the polarity of the polepieces is wrong and must be corrected by changing the direction of the current through one of the coils.

The High-Power Diesel Engine of Nurnberg*

By W. LAUDAHN
Chief Construction Engineer, M. A. N. Co.

Discussion of the difficulties met with in designing a 12,000-hp. Diesel engine—Account of the explosion that wrecked engine.



AT THE time the construction of the 12,000-hp. M. A. N. Diesel engine was undertaken, the largest marine oil engine yet built was a 900-hp. unit in six cylinders, while the new proposal called for the development of 2,000 hp. per cylinder.

The boldness of such an undertaking was best understood by the staff who, like the author, spent nearly eight years upon the work. A volume would be required were one to attempt to describe the countless detail investigations required for overcoming the ever renewed onslaughts of difficulties.

In August of 1909 the Nürnberg works of the M. A. N. thinking that its marine Diesel engines had been sufficiently well tried out and developed to interest the German Admiralty, sought a trial of one of their units of a maximum of 800 hp., suggesting the tender "Drache" as being well adapted to the test. On the 25th of August the Marine Office declared itself as being interested only in units of 2,000 hp. and upward per cylinder, thus creating a sensation.

The Firm Decides to Investigate

After due consideration this startling proposal was answered by the declaration that the firm would investigate the problem. They placed great reliance upon their experience in the development of marine Diesel engines of smaller dimensions and especially upon their experience in the construction of large gas engines, which, after great technical difficulties had been overcome, had reached a high degree of perfection at the Nürnberg works. An agreement was arrived at, between the M. A. N. and the Marine Office the conditions providing the building of a three-cylinder experimental set so constructed as to be readily convertible into a six-cylinder engine. The three-cylinder set was required to deliver 6,000 hp. at a maximum of 165 r.p.m. or to develop 2,000 hp. in each of its double-acting two-stroke-cycle cylinders. It was to remain under searching test upon the test blocks of the M. A. N. works in the presence of the representatives of the Admiralty until in their estimation its complete adaptability to work aboard ship was demonstrated. Thereupon, the construction should be carried into six cylinders. The complete engine should be given an endurance test at 12,000 hp., but the Marine Office might reject the engine only in case it failed to deliver less than 0.9 of its rating, or less than 10,800 hp., provided the practicability of the unit for ship work be suitably demonstrated.

A difficulty was encountered at once in that the height available under the armored deck in ships of the line of that period would not accommodate a Diesel of the usual proportions of the required capacity without building an armor bell over the engine space. The cylinder bore was established at 33.46 in. and the stroke at 41.34 in. To diminish these dimensions would require an increase in the revolutions which would not be advantageous either to the engine itself or to the propeller efficiency. The result of these restrictions was the pocket construction shown in Fig. 1.

The greater part of the compression space was not, as generally, between the piston and cylinder head, but was to the side in pockets, provided in the head. These pockets were of rectangular cross-section with well-rounded corners, there being four above and four below. Into each pocket a spray valve opened at right angles to the cylinder axis and a scavenge valve in an inclined position, while the starting valves were seated in the head vertically from above and below, permitting access of the starting air above or below the piston as directed by the valve events. To handle the valves two upper and two lower horizontal layshafts were driven by two vertical layshafts, one each side of the crankshaft. The starting valve and the most important part of the reverse gear were pneumatically actuated. All the valves were united in the heads in order to permit building the cylinder in the simplest possible tubular form. Aside from a pair of oil tubes only the exhaust ports at mid-cylinder pierced the bore. These ports had the form of parallelograms between which, for the guiding of the piston rings, were inclined bridges tying the upper and lower cylinder sections together.

Material Selected

Grey iron with some admixture of wrought iron was chosen as the material for cylinders, pistons and heads. The cooling water for the head and cylinder was taken from the Nürnberg water mains and was circulated through the cooling tower of the works. The piston on the contrary, was cooled with lubricating oil entering through a pipe in the piston-rod bore and returning between the pipe and piston-rod bore. The oil was led to the crosshead through links.

The following details of the installation of the three-cylinder engine on the test stand should be mentioned:

A lighter shaft was coupled to the crankshaft for driving the auxiliary pumps for cooling oil, cooling water and lubricating oil. From this shaft was driven the triplex scavenging pump. The scavenging pump

*Extract of article appearing in *Zeitschrift Des Vereines Deutscher Ingenieure*, Dec. 8, 1923.

for the six-cylinder engine was also in six-cylinder form, having three cranks and two cylinders on each in vertical tandem.

An electric dynamometer and a Froude water brake were provided with due regard to simulating as nearly as possible the conditions of reversing a propeller. A 350-hp. compressor set was provided for injection air, handling 18 cu.ft. of free air per sec. This proved to be insufficient for the 6,000-hp. unit, and additions to the compressor capacity were required to permit full-load operation.

In the spring of 1911 the assembly was ready for test. From this moment began a chain of disappointments. The pocket form, due to heat stresses, did not

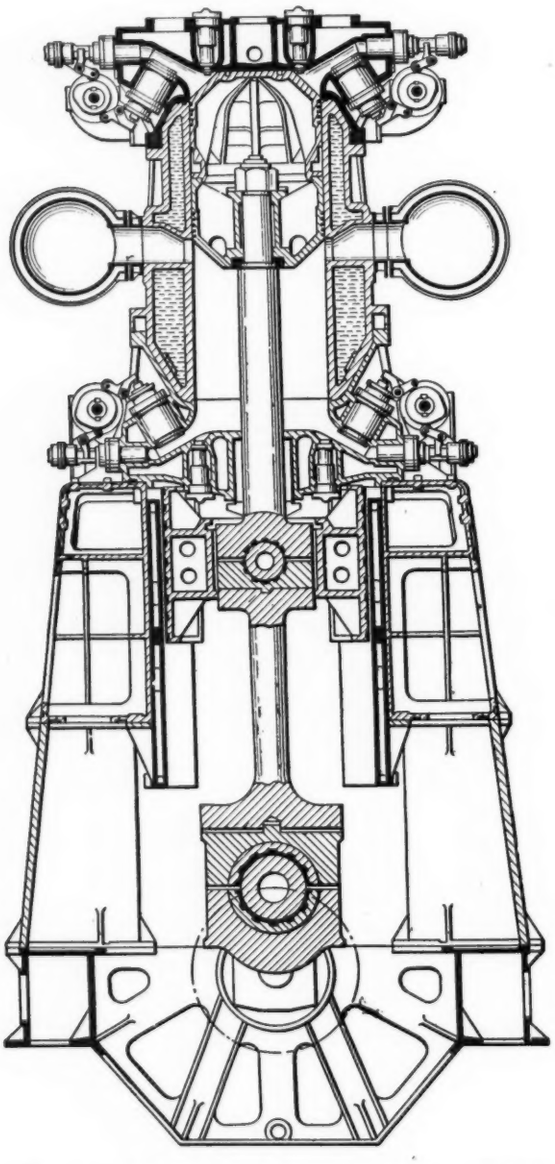


Fig. 1—Original design of 12,000-hp. Deisel

survive even comparatively light loads. Fractures appeared in the corners even when well rounded, nor did it help when the pockets were designed with an elliptical cross-section. The fractures then appeared mainly at the junctions of the pockets and cylinder wall. Further broad rounding of these junctions made possible an increase of capacity over the earlier conditions, but under endurance test the integrity of the construction proved to be insufficient. Radial fractures appeared in the lower head, starting at the piston-rod opening. In the upper part of the piston ribs prevented free expansion. Often the entire upper piston head broke in so that the cooling oil escaped into the cylinder and

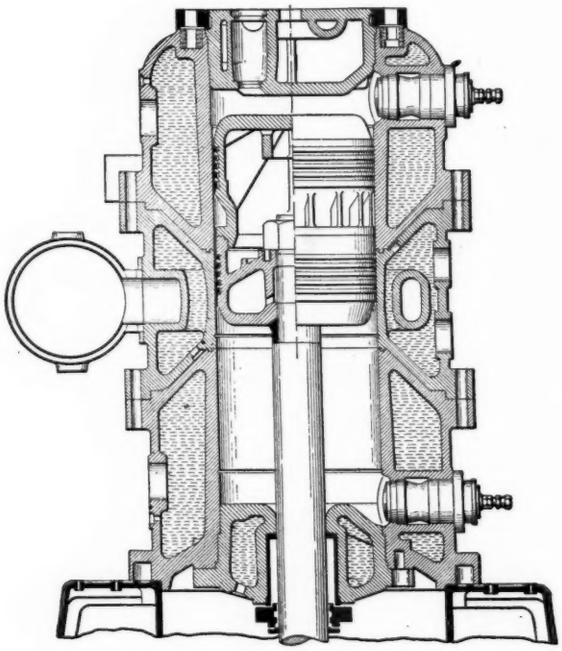


Fig. 2—Experimental cylinder No. 1

was ignited with heavy detonations and the development of clouds of thick black smoke. At the lower part of the piston the bearing ring between piston and piston-rod chamfer was especially bad and the piston body broke off around the counterbore provided for this bearing ring.

The design of the cylinders was also unfavorable. The inner wall became very hot and expanded, while the jacket wall remained cold and set up a resistance to the expansion. The result was that the cylinder crushed in at the exhaust-port bridges. The worst of all was that the broken bridges bowed inward so that the piston rings were crushed together and broken and the piston was seized and torn apart. Careful mathematical investigation revealed that union between the upper and lower cylinders through the exhaust-port bridges was not required for strength and that the exhaust belt, which was continuous with the outer jacket, would serve to carry the load. So it was resolved to cut the bridges through on the replacement cylinders and to insure the guiding of the piston rings by staggering the cutting. The bridges were also so formed that their expansion under heat would tend to bow them outward rather than inward. Since, however, this arrangement did not give satisfaction, a new construction was invented, as shown in Fig. 3, the sinuous ends of the upper and lower cylinders interlocking and projecting past each other by the amount a to give proper guidance to the piston rings. It was sought to reduce the difficulties with the piston by narrowing the ribs in the upper part to permit freer expansion. Beside these measures it was sought to make a gain by a

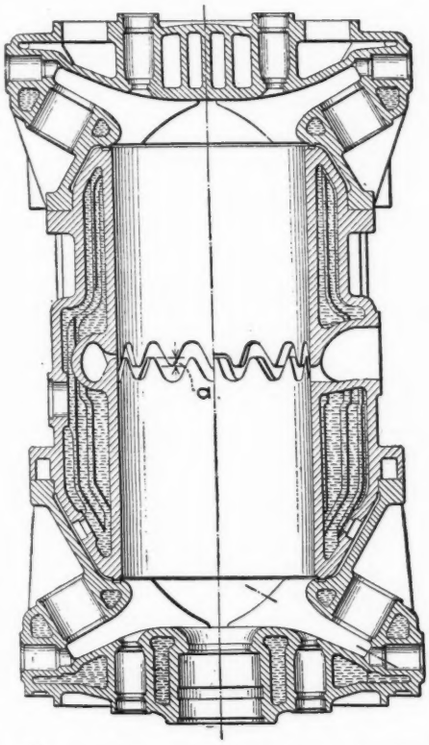
change in material, the piston parts being ordered of steel castings, which, however, with the design of piston provided, showed no improvement over cast iron.

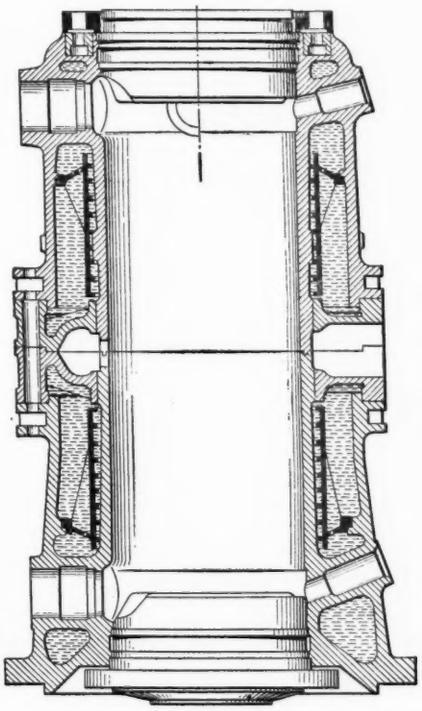
Another phenomenon of this first series of experiments made much trouble. The upper guide bushings of the scavenging pump piston ran hot repeatedly. Babbitting the sliding surfaces helped little. This derangement resulted in accumulated loss of time in the experimental work, so that the operating personnel, ignorant of the serious results possible and without consulting the engineers, adopted the rather doubtful means of lubricating this guide bushing with great quantities of Kalorizid, a preparation for the cooling of warm running bearings. Owing to the construction of the scavenge pump this Kalorizid found its way into the scavenging air and was borne along the rather long air main into the receiver in the upper part of the engine frame and thence, upon opening of the scavenging valves, passed up the riser into the combustion space of the working cylinder. The dire explosion Jan. 30, 1912, resulted from this cause and brought the first part of the experiments to a sudden and sad conclusion.

Later investigation showed the following unfortunate chain of causes: A broken scavenging valve lever, the fractured stump of which riding against a cam screw, raised a scavenge valve out of time. Flame being present in the cylinder, it followed the oil-coated pipes to a pool of oil in the scavenging-air receiver, which being part of the frame and ribbed, could not be completely drained by the cocks provided for the purpose. The accumulation of oil had resulted from the excessive lubrication of the scavenge-pump bushing, and ignition was facilitated by the ether content of the Kalorizid. An explosive wave was set up in the long air main and the flame, bursting out one end, ignited the contents of the fuel-oil tank, creating instantly a sea of fire. The oil-soaked wood scaffolding erected about the engine took fire. This was the nature of the accident. Despite this misfortune it was decided to continue the work. The original plan was altered only in that it was proposed to continue with a single cylinder instead of three, which promised to result in less expensive work and more rapid results. Up to this time three different cylinder outfits had been tried out. Five others were later tried in succession and will be briefly described. It should be noted that the numbering of these cylinders after the explosion began anew with No. 1.

Experimental Cylinder No. 1—The basic difference between this cylinder, which is shown in Fig. 2, and previous constructions lies in the arrangement of the fuel and scavenging valves, which were removed from the cylinder head and lie horizontally in the cylinder body. The pockets were abandoned. The over-all height was taken care of by other constructive means. By these measures the form of the cylinder head was made much simpler though the cylinder was more complicated. The cylinder was made in three parts with the false hope that the packing between the three units would be sufficiently elastic to absorb the difference in expansion between the inner and outer walls. The exhaust-port bridges were cooled, and this resulted in a new difficulty. When they broke, cooling water flooded the exhaust pipe and could not be kept out of the cylinders. The early cylinders employed oil cooling of the piston, but this had been abandoned in favor of water cooling.

The trials, which began in August, 1912, continued only a short time. Very soon cracks appeared in the scavenging-valve openings, soon deepening sufficiently to permit entrance of the cooling water. The cooled exhaust-port bridges bowed in to the cylinder, causing seizure of the pistons. After forty-two hours of operation the cylinder found its way to the junk.





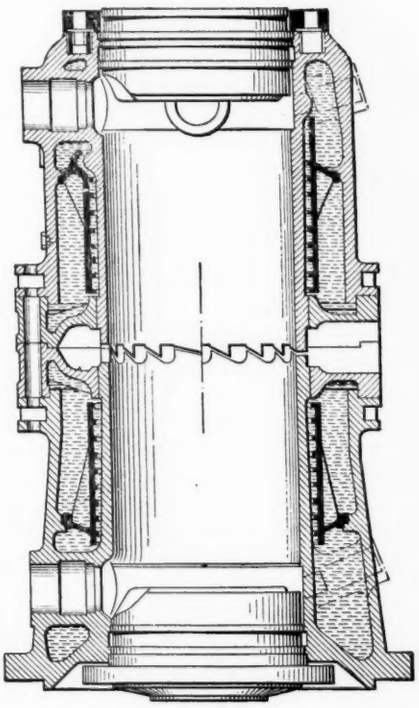


Fig. 3—Alteration in exhaust ports *Fig. 4—Experimental cylinder No. 2* *Fig. 5—Experimental cylinder No. 3*

The essential difference between No. 1 and No. 2 lay in the design of the mid-portion of the cylinder, now constructed in two pieces shrunk respectively upon the upper and lower cylinders. The exhaust-port bridges interlocked by tongue and groove, so that lengthwise expansion was possible but outward bending could not occur. It was sought to overcome the cracking about the scavenging-valve openings by enlarging the fillets at the junction. The cylinder cooling was improved by inserting cast-iron sleeves in such fashion as to cause the water to pass spirally about the cylinder walls and upward at high velocity—a good idea, which proved useful in later cylinder constructions.

After installing this cylinder, cylinder-wall temperatures were measured for the first time with thermo elements. With comparatively light loads they proved so high that it was believed that the cause of the fractures had been discovered. Experiments with water injection to reduce the wall temperatures had not the desired result, and the combustion was so injured by this measure that it was quickly discontinued. Cylinder No. 2 successfully withstood loads up to 1,500 hp. Above that, however, cracks developed first at the scavenge-valve openings, then from the inner corners of the relief valve and starting-valve spigots, as well as in the upper head and finally in the upper part of the piston. This construction was abandoned and cylinder No. 3 took its place. Since only the upper part was built, the engine was tested as a single-acting unit. This cylinder in 267 hours of operation made it appear that the troubles with the exhaust section were overcome, and attention was therefore turned to guarding against valve-opening fractures above all other considerations. Test cylinder No. 3, which is shown in Fig. 5, is distinguished by an experiment in design. A swell of metal is carried around the scavenging-valve openings, thus offering considerably more resistance to circumferential tension in the valve openings without excessive thickness of the wall. The exhaust section was only so far altered that the formerly horizontally arranged junctions in the exhaust bridges were now inclined in order that the piston rings might pass freely over them. This made the difficulties of producing the tongue-and-groove construction shown in Fig. 2 so very great that it was abandoned. Special tubes were inserted in the upper head to improve the cooling. The piston construction was not altered, broken parts being replaced by spares.

This cylinder did not have a long lease of life. It was placed in service on March 25, 1913, and by the middle of April was set aside on account of cracks, having been in operation only fifty-eight hours. The mean indicated pressure 105 lb. per sq.in., giving 927 hp. for the single-acting cylinder at 117 r.p.m., was the highest yet reached by the experimental engine. The cylinder was broken into pieces under the steam hammer for examination of the fractures, and it was here learned that the strengthening at the valves had really been advantageous. The cracks were, contrary to earlier experience, mostly surface manifestations. Had this been known, the cylinder would have been kept longer in service.

The hopes of better service awakened by cylinder No. 4, then in production, now took strength as its design followed the same line of thought as expressed in the previous one.

[*The conclusion of this discussion will appear in an early issue*]—*Editor.*

Steam Boilers

A Catechism by Warren Hilleary Served in Small Doses and Extending Over a Number of Issues

110. The construction of a boiler is such that a double-riveted lap seam gives ample theoretical strength; what reason, then, is there for assuming that a double-strap butt seam is more desirable?

The objection to lap seams is that they permit a bending action that may cause the sheets to crack under the lap and thus produce a dangerous hidden defect. This does not occur to an objectionable extent in butt-strap construction.

111. Why are not braces used in a bumped head?

They are unnecessary. The pressure within a vessel tends to form it into a perfect sphere. A bumped head is a portion of a nearly perfect sphere, and since the drum of the vessel is cylindrical, it follows that the limit of safe pressure for the drum is reached before the strain on the bumped head is great enough to exceed its safe pressure. Ordinarily, therefore, bracing is unnecessary. If the head is so large in diameter that it is not practical to bump it to a true radius, then braces become necessary.

112. In patching firebox sheets of vertical or locomotive types of boilers, the patches are generally placed on the outside. Why?

It is more convenient and less expensive to place the patch on the outside. Patch bolts are generally used, and if the patch were placed inside, the patch bolt holes in the furnace sheet would have to be drilled large enough to allow clearance for these bolts. The edge of the patch could not be calked, and considerable leakage might take place between the patch and the sheet through the clearance for the patch bolt and out past the bolt head. In placing the patch on the outside, the patch bolt holes in the patch would have to be drilled to allow as much clearance, but the only opportunity for leakage would be between the threads in the sheet and the threads on the bolt. Leakage here is not likely to take place if the work is properly done. Moreover, if the patch were placed on the inside, it would be necessary to cut an oval hole in the sheet around the defective portion, and thus remove more material than advisable.

113. On longitudinal lap-seam boilers in what direction should the inner lap point; downward or upward? Give reasons.

The inner lap joint should point downward to lessen scale accumulations on the shell along the edge of the sheet.

114. Rear heads of horizontal-tubular boilers are flanged inward, while front heads are frequently flanged outward. What governs the practice in this respect?

It is desirable that all seams should be wet seams. The flanging inward of the rear head provides a wet seam at a point where it is especially needed on account of the temperature of the furnace gases at that point. The flanging outward of the front head makes riveting of the seam more convenient than would be the case were the head flanged inward, and since the gases in contact with the front head seam are much lower in temperature than they are while passing the rear head seams, a wet seam for the front head is not so essential.

Cylinder Lubrication When Using Saturated and Superheated Steam

By John D. Morgan*

The lubrication of steam-engine cylinders has always been one of the real problems that the lubrication engineer has had to contend with. For many years it has been common knowledge among engineers that the best running properties of sliding surfaces were developed only when the machine had been in operation for a sufficient time to produce the hard, so-called glazed surface. This glazed surface is a vitreous, amorphous layer on top of the metal, and one rightly concludes that there is something more than a bearing surface consisting of hard points embedded in a matrix of softer material and that the mechanism of two surfaces in sliding contact is much more complex than is generally assumed.

Experiments have shown that in a well-designed and properly constructed steam cylinder the friction coefficient increases slightly with the steam pressure. With a scanty oil feed the friction coefficient is large and extremely variable when the cylinder is under pressure. If the oil feed is shut off, the friction increases rapidly when pressure is on the cylinder, the increase being slow in case atmospheric pressure only is in the cylinder. These facts give an idea of the difficulties that have arisen in lubrication since high speeds, high temperature and high pressure have come into general use.

Atomization of Oil the Basic Requirement in Steam-Cylinder Lubrication

The basic requirements for all steam-cylinder lubrication is that of securing a complete atomization of the liquid oil. The old method of oil-cup feeding to the valves and cylinder was no doubt the cause of all the cry about the difficulty of obtaining proper cylinder oil where superheated steam was used. This method gave trouble even with saturated steam, and when cost curves were kept it was found that the average lubricating cost per 1,000 kilowatt-hours generated was about 25 cents.

The desire of the progressive engineer to cut these costs gave birth to the new idea of lubrication; namely, the feeding of minute quantities of oil with every stroke of the piston, thereby insuring that the oil was more or less atomized and was reaching all the working and rubbing surfaces of the cylinder. In one plant where the lubrication cost was 25c. per 1,000 kw.-hr., when using oil-cup lubrication, the installation of a sight-feed oil pump cut the cost to 10c. per 1,000 kw.-hr. The installation of the sight-feed pump by no means insures efficient and proper lubrication, but when the oil is applied at the proper point, it will be carried to all parts reached by the steam.

The proper point of application is that point which is far enough away from the valves and cylinders to insure a complete atomization of the oil. This distance is a function of the steam piping construction; that is, the presence of tees and elbows will often trap out the oil and cause it to flow along the pipe walls in a liquid state. Once the point of application has been determined, the oil from the sight-feed oil pump should be injected into the center of the steam flow through an atomizer to insure the oil being broken up into a spray and evenly distributed.

*Consulting engineer, New York City.

The choice of the proper oil is a matter of extreme importance. For instance, it is practically a necessity to use a compounded oil for a saturated steam engine, but in superheated steam cylinders the subject of compounded versus pure mineral oils becomes a frequently discussed matter. A great many objections have been made to the use of compounded oil for superheated steam, the main point of discussion being the likelihood of the animal oils breaking down under high temperatures and causing the formation of carbon and acid products. It is an established fact that steam cylinders of practically every engine will operate at some time or other on saturated steam; even when the steam is superheated at the time of release, saturated steam will be formed in the cylinder on the exhaust stroke.

Using Low Flash-Point Oils

When correct and full atomization of the oil is obtained, it will be found that it is not only possible but practical to use a cylinder oil of lower flashpoint than that of the temperature of the steam. This is partly due to the fact that the flash points of oils, when under steam pressure and in the absence of air, are increased by a considerable figure, and an oil can be safely used when the steam is 100 deg. higher than that of the oil flash point in open air.

On cylinders using a high degree of superheat the temperatures of the valve surfaces and cylinder walls are considerably higher than saturated-steam temperatures; this makes it necessary to use a heavy-bodied oil. Oils for this service should have viscosities ranging from 135 to 160 seconds Saybolt at the boiling point of water. It must be borne in mind that these heavy oils require a longer period for vaporization, and a smaller quantity of oil should be fed than when using a lighter-bodied oil.

The average engineer condemns the oil upon finding carbon deposits in the cylinder of an engine using superheated steam. Such a deposit often does not constitute a good and sufficient reason for the rejection of the oil, for most investigations have shown that it is not the decomposition of the oil under high temperature that causes carbon deposits, but rather that it is due to the excessive amounts of oil fed to the cylinder. Excessive oil feeding will be indicated by an accumulation at the ends of the valve travel or in the counterbore of the cylinder. In many cases of reported carbonization of oil investigation has shown that these deposits are largely composed of dirt carried over in the steam main from the boilers, which at various times have been foaming or priming.

Lubrication of Special Engines

The foregoing remarks do not necessarily apply to the lubrication of locomotive cylinders, steam-shovel or tractor-engine cylinders using superheated steam. In these classes of engines the conditions of operation combined with the standard practice of feeding oil directly to the valves, and coupled with the short time available for atomization, makes necessary the use of a light-bodied oil, which will evaporate quickly.

By using the methods described, it will be found that as a general practice, it is no more difficult to lubricate a steam cylinder using a high degree of superheated steam than it is a cylinder using saturated steam. The troubles experienced should not always be blamed on the oil, for a proper piston ring means everything when superheated steam is used.

Action of Caustic Soda on Boiler Steel*

Preliminary Report of M. I. T. Experiments

By R. S. WILLIAMS and V. O. HOMERBERG

INVESTIGATIONS indicate that electrolytic hydrogen and caustic soda are factors in the failure of boiler metal under stress. The action is mainly in the impurities that are present between the crystals of the metal. Of these impurities the hydrogen acts chiefly upon the oxides, while hot caustic-soda solutions dissolve out the sulphides.

THE continued use of natural or treated waters containing sodium bicarbonate often leads to an abnormal type of failure in boiler steel. These failures are characterized by the appearance of cracks between the crystals in the riveted-joint areas. In the course of an extended investigation of failures of this kind, carried out at the suggestion of the Babcock & Wilcox Co. and with their continuous co-operation, certain results have been obtained which seem to be of sufficient importance to justify advance publication before the investigation is completed.

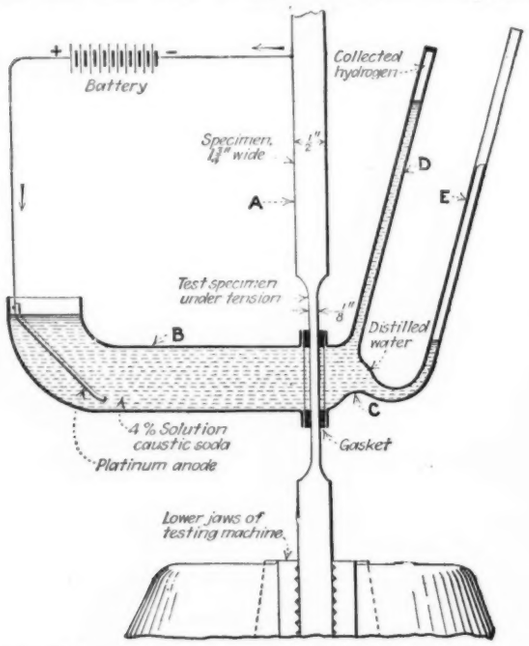


Fig. 1—Schematic view of apparatus used to measure hydrogen penetration

The fact that mild steel is made distinctly brittle under the influence of cathodic[1] hydrogen has been known for some time. To study the effect of cathodic hydrogen on mild steel use was made of the apparatus shown in Fig. 1, which is arranged as follows: A test bar *A* is placed in a testing machine so that it may be subjected to any desired tension. Two irregular glass vessels, *B* and *C*, have large open ends clamped on the two sides of the test bar, with gaskets to maintain a liquid-tight joint. Tube *B* contains a 4 per cent solution of caustic soda, into which dips a platinum electrode. The wire leading from this goes to the positive terminal of an electric battery, the other terminal leading to the test specimen. Thus the flow of current is from the battery to the platinum anode, then through the caustic-soda solution to the test specimen which constitutes the cathode and from this back to the battery. This flow of current deposits electrolytic hydrogen on the exposed portion of the test bar.

The glass vessel *D* at the right side of the tensile-test bar contains distilled water. This, as is also the case with the tube at the left, is protected from carbon dioxide from the air by means of U-tubes (not shown) filled with soda lime.

At the start the branch *D* is filled with distilled water and closed at the top. During the test hydrogen gradually passes through the specimen to the distilled-water container where the bubbles rise in the arm *D*, thus permitting volumetric measurement. The displaced water rises in *E*.

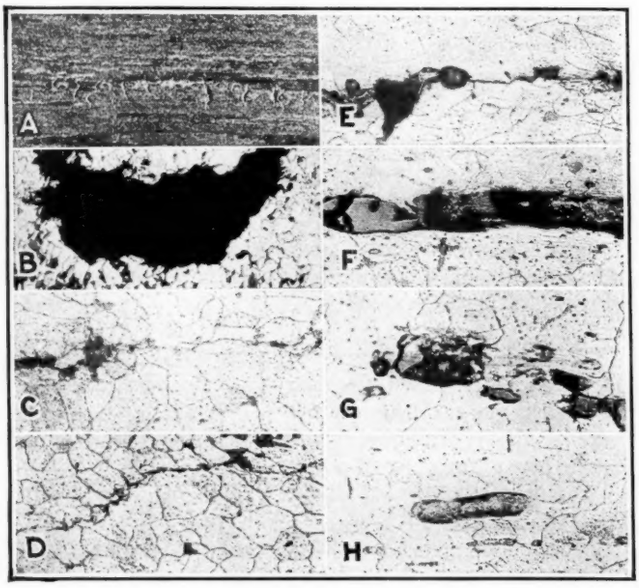


Fig. 2—Photographs from first test bar (X equals number of magnifications)

A—(surface view) blister cavities, 3*X*; B—Cross-section of blister, 75*X*; *C*, *D* and *E*—intercrystalline cracks in test bar, 150*X*; *F*, *G* and *H*—partially and completely altered slag inclusions (*F* and *H*, 250*X*; *G*, 500*X*).

The study of the penetration extended over a period of about one month, during which time readings were taken at regular intervals, before the bar was loaded, while loaded below the yield point, at the yield point, and finally above the yield point. The specimen was finally broken and sections prepared for microscopic examination.

The difference in the rate of penetration of the test

*Paper presented before Boston Chapter of American Society of Steel Treaters. The authors are associate professor and instructor, respectively, in metallography and Babcock & Wilcox fellows at the Massachusetts Institute of Technology.

[1]Cathodic hydrogen is the electrically charged hydrogen that forms the cathode when an electric current passes between two pieces of metal submerged in a solution.

bar when in the unstrained and in the strained condition was marked. Stressing beyond the yield point did not appear to have any further effect on the rate of penetration.

Several interesting observations were made. A black deposit formed on both sides of the test bar, and large masses of black material were obtained on the distilled-water side. Furthermore, the distilled water had a strong odor of hydrogen sulphide when the apparatus

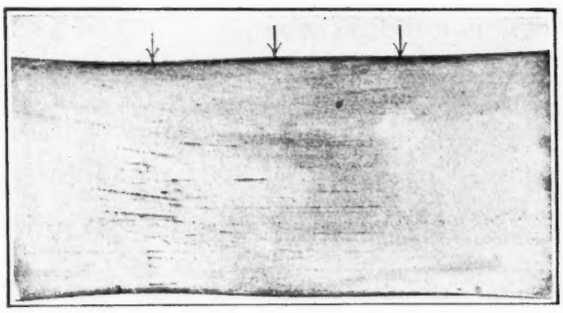


Fig. 3—Test bar stressed above yield point under the action of cathodic hydrogen

Note that center portion exposed to hydrogen contracted less than adjacent sections above and below it.

was disconnected. Chemical tests indicated that the deposit was probably iron sulphide.

The specimen broke with a dull sound. A number of blisters had formed on the side of the caustic solution and in the direction of rolling of the material. These blisters, on polishing for microscopic examination exhibited crescent-shaped cavities, as shown in Fig. 2 at *A* and *B*. Intercrystalline cracks are shown at *C* and *D*. *E* shows a crack, which developed from one terminus of a blister; and completely altered slag areas are shown at *F*, *G* and *H*.

A similar experiment was made on a second test bar. The action of cathodic hydrogen extended over a period of several weeks, during which time the stress on the specimen was gradually increased. The specimen was removed from the holder after the yield point had been passed and prepared for microscopic examination. Again, partly and completely decomposed slag inclosures and many intercrystalline cracks were visible. The rate of penetration of the hydrogen through the steel increased as the tensile stress was increased, reaching a maximum with the passing of the yield point.

In each instance, immediately after the stress was applied, there was a marked temporary decrease in the rate of penetration. This decrease was especially noticeable immediately after the yield point was passed. Hydrogen sulphide was again detected in the distilled water, thereby suggesting the possibility of the reduction of the sulphide in the steel by the penetrating hydrogen. This conclusion is not positive, however, since sulphur was found in the gutta percha gaskets with which the specimen was held tightly in contact with the glass receptacles.

A marked effect of the action of cathodic hydrogen was noticed as the breaking load was approached. A necking occurred at points just outside of the part exposed to the action. The contrast in the ductility of the affected and the unaffected parts is shown in Fig. 3.

Many bits of evidence in this and earlier experiments indicated a reduction of the slag under the influence of cathodic hydrogen. A series of studies was begun to determine the actual effect of cathodic hydrogen on slag as present in iron and steel. Wrought iron containing considerable slag of the duplex type (containing two micro-constituents) was subjected to the action of cathodic hydrogen. The slag masses showed a bluish-gray constituent and a darker or dove-colored one. The lighter constituent was readily reduced. The micrographs in Fig. 4 show the appearance of the slag areas before and after the action.

A long slag streak in mild steel, the same material from which the tensile test bar referred to was made, was acted upon by cathodic hydrogen, with the result shown in Fig. 5. The reduction was rapid.

The chemical composition of the slag in the wrought iron and in the mild steel could not be determined accurately, and as the experiments with the wrought iron showed the action of the cathodic hydrogen to be selective, a series of experiments was made for the purpose of studying the effect on inclusions of definitely known composition artificially introduced into mild steel.

Cathodic hydrogen had a marked effect upon iron oxide (FeO). Manganese oxide was much more slowly reduced. Iron sulphide was acted upon but slightly, while manganese sulphide was attacked somewhat less readily than iron sulphide. Experiments on high-quality open-hearth iron gave added evidence that cathodic hydrogen has little effect on the sulphides.

The next series of experiments was carried out with a similar set of specimens containing artificial inclusions in order to study the action on them of boiling caustic-soda solutions of varying concentrations. For this purpose solutions containing 0.1, 0.5, 1, 2 and 5 per cent sodium hydroxide were used and the specimens removed at successive intervals as follows: 10 minutes, 30 minutes, 1, 2 and 5 hours. All specimens were

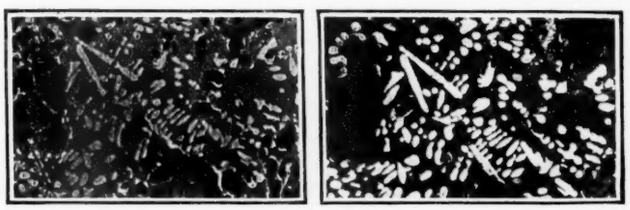


Fig. 4—Slag in wrought iron before (left) and after action of cathodic hydrogen (unetched, 250X)

Fig. 5—Slag in mild steel before (left) and after action of cathodic hydrogen (unetched, 100X)

examined before boiling to determine the condition of the inclusions.

In the 0.1 per cent caustic soda solution the iron oxide and the manganese oxide were intact after 5 hours. After 2 hours the manganese sulphide became slightly pitted and the iron sulphide was completely removed. The iron sulphide was partly removed after 10 minutes. In the 0.5 per cent solution similar results were obtained except that the iron sulphide was removed after 1 hour. The oxides remained intact in the 1 per cent solution. After 10 minutes the manganese

sulphide became pitted and the iron sulphide was removed. Similar results were obtained with the 2 and 5 per cent solutions, except that the manganese sulphide was attacked after 10 minutes in the 2 per cent solution and completely removed after 10 minutes in the 5 per cent solution.

A study of the action of a boiling 2 per cent solution of caustic soda on pure iron containing varying proportions of iron and manganese sulphides was made. Iron sulphide was added to pure electrolytic iron. The micrographs of Fig. 6 show the network of iron sulphide before exposure and after exposure for 2 and 10 hours. The iron sulphide was completely removed.

From this point of view the most dangerous inclusions in steel are evidently the oxides and the sulphides. The experiments on artificial inclusions show conclusively that iron oxide is more readily attacked by cathodic hydrogen than any other of the common inclusions and that the sulphides are the inclusions most readily attacked by boiling caustic solutions.

The action of cathodic hydrogen on oxides is strikingly shown in Fig. 7. The material is bessemer steel that had been rejected because of too high an oxygen content. It was photographed after its exposure to the action of cathodic hydrogen. The blisters were undoubtedly produced by the action of cathodic hydrogen on the oxide.

A study was undertaken of actual boiler plate from boilers that had failed in service, the analyses of which came within specifications in each case. These failures generally occurred in cases where the water supply showed considerable alkalinity. The results will be made public in the near future.

The facts herein described—namely, the reduction of oxides by cathodic hydrogen and the removal of sulphides by caustic-soda solutions—lead directly to an understanding of two of the factors involved in the intercrystalline cracking in steel. As molten steel solidifies, the impurities are to a great extent rejected to the grain boundaries so that much of the iron oxide and any iron sulphide that may be present would be found in places where their removal would tend most strongly toward a weakening at the boundaries. This effect would be aggravated if the steel was under tension as is general in the case of boiler plates and in rivets. Wherever tension exists, very small capillaries must be formed as a result of the lack of adhesion between the inclusions and the metal itself. The cathodic hydrogen would produce water as the result of the reduction of iron oxide and cause an increase in volume at the grain boundaries. This increase in volume will have a tendency to force the grains apart.[3] If to the stresses already present in the steel are added these stresses, the total may be sufficient to produce very small cracks. This action would be especially marked at the rivet holes in a boiler where the stresses are at a maximum, the stress at the edge of a circular hole being approximately three times the average stress.

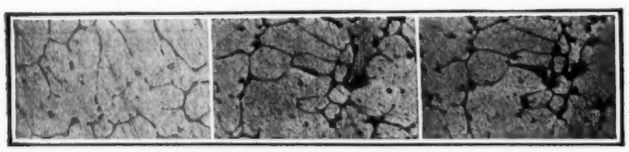


Fig. 6—Iron sulphide, artificially introduced (unetched, 250X)

Left, original condition; center, boiled in caustic 2 hours; right, boiled in caustic 10 hours.

A tentative explanation may be given of the marked temporary decrease of the rate of hydrogen penetration through the test bar, referred to previously, following each application of stress and which became most marked at the yield point. The capillaries produced by the combined effects of stress and the action of cathodic hydrogen on the minute inclusions become filled with débris, the action being most marked at the yield point where actual slippage occurs.

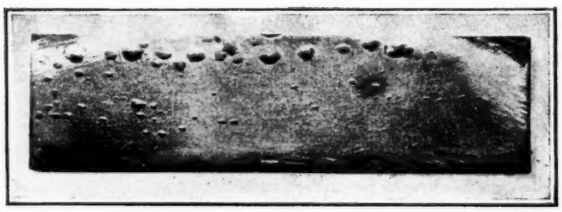


Fig. 7—Blisters on steel caused by cathodic hydrogen

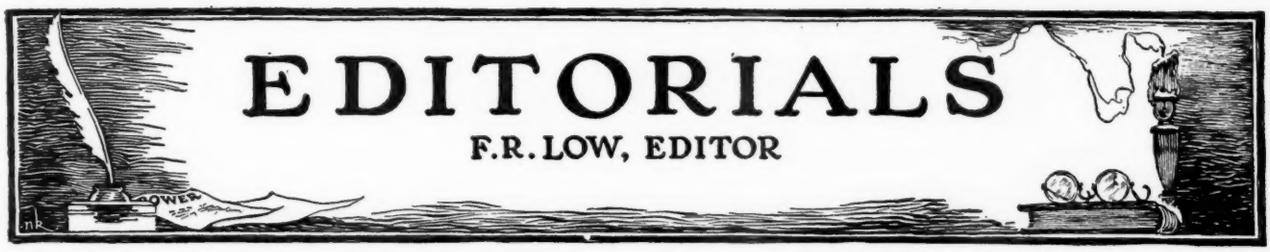
Conclusions

The results obtained lead to the following conclusions:

1. During the crystallization of steel the impurities, to a considerable extent, are rejected to the grain boundaries.
2. The oxides and sulphides are two of the prime factors in caustic embrittlement.
3. The oxides are reduced under the influence of cathodic hydrogen.
4. The sulphides are removed owing to the action of hot caustic-soda solutions.
5. The removal of the sulphides produces a surface condition favorable to progressive corrosion.
6. Assuming that progressive corrosion starts with the removal of the sulphides, the corrosion will be greatly accelerated if the material is stressed. Furthermore, when the steel is under tension there is a tendency for the matrix to pull away from the inclusions at the grain boundaries and in this manner to produce small capillaries into which the corroding solution can penetrate.
7. In stressed areas containing oxides, the volume increase due to the reactions with cathodic hydrogen, may produce stresses which, added to those initially present, may cause cracking.
8. It seems evident that hydrogen acts in three ways to produce embrittlement: First, the temporary brittleness caused by adsorbed hydrogen (as in acid pickling); second, it acts to reduce oxides; third, its effects due to the change in volume at the grain boundaries, resulting because of the production of water. This latter volume increase would create a stress which, added to those originally present, may cause cracking, especially at those points where these stresses are at a maximum.

Acknowledgment is made to Messrs. Zavarine and Yarotsky for assistance given, and especial thanks are due Prof. C. L. Norton, of the Massachusetts Institute of Technology, for his interest and co-operation.

[3] Similar effects are obtained when copper containing copper oxide is annealed in a reducing atmosphere. See Journal Institute of Metals, No. 1, 1921, Vol. XXV.



Power Factor Correction a Question of Economics

NOTWITHSTANDING all that has been accomplished during the last ten years toward a solution of the power-factor problem as applied to alternating-current systems, there still remains much to be done. The total investment in additional power-generating and distributing equipment required to take care of the increase in kilovolt-ampere load due to low power factors, on the power systems of this country, is tremendous. One large company reports that for its system alone this figure is over eleven million dollars, and the increased annual operating costs of the system due to low power is nearly two million dollars. In this case the average power factor of the load was about seventy-three per cent.

Much has been done through interconnection of power systems toward keeping down the amount of reserve equipment and consequently the total investment to supply a given load. Correction of low power factor in the system also makes available additional power capacity, and there are many instances where plant extensions have been postponed indefinitely, simply by correcting the power factor of the load on the existing plant. Forty-three per cent greater kilowatt load can be supplied by a given system at one hundred per cent power factor than at seventy per cent. Not only this, but when supplying a load of forty-three per cent more kilowatts the reserve capacity of the system is the same as before the power factor was improved.

There are three parties interested in this problem, the equipment manufacturer, the central station and the power user. The latter two must take the initiative, since before the manufacturers can be expected to incur the expense of producing power-factor correcting and metering devices, there must be a certain assurance of a market for such apparatus supported by the proper sentiment. This must be created by those who generate, distribute and use the power, particularly those who generate and distribute. On some systems the customer's load has been practically forgotten and corrective means have been installed on the transmission system. This, however, is only going halfway and taking the path of least resistance. The place to correct power factor is at the load, since this not only reduces the losses over the entire system, but also makes additional capacity available from the power-user's feeders back to the power house.

Before much headway with this problem can be expected, some incentive must be given to the power consumer. There is little use of blaming the manufacturers for selling induction motors for loads that could be driven by synchronous machines or other types of high-power-factor equipment, that may cost considerably more than the simple squirrel-cage type motor, unless the power companies are willing to back the manufacturer by giving the consumer some reduction in rates for making the additional investment to maintain a high power factor. Especially is this true when the squirrel-cage or slip-ring type of motor will, as a power medium, be just as satisfactory as the more expensive machine.

Some companies have in their rate contracts a power-factor clause which they enforce. These have worked out satisfactorily in most cases, which shows that equipment and methods have been developed whereby it has been found profitable to apply power-factor correction methods. Such a scheme generally carried into effect would save millions of dollars in investments in power generating and distributing equipment, besides the saving in power due to a reduction in losses, all of which would reflect to the interest of both the producer and user just as interconnection of power systems has done.

Powdered Fuel and the Purchase of Coal

COAL was purchased on the B.t.u. basis by many industries and central stations about ten years ago. Elaborate specifications were prepared with limits on the allowable moisture, ash and sulphur, and penalties were imposed if certain percentages of these were exceeded. At that time excessive amounts of either of these three substances were considered to have deleterious effects on the efficiency of combustion and the operation of the furnaces. The fusibility of the ash was also a factor given close consideration.

The imposing of these penalties led to frequent disagreement between purchaser and coal dealer, for the seller was not able in every case to control all these factors. This was particularly the case with regard to moisture, for the coal was frequently rained on during transit. Hence, when the coal shortage appeared early in the war, all specifications were discarded and buyers were usually glad to get coal so long as it would burn, frequently quite regardless of price. Coal miners became careless in the preparation of coal, and there was a general laxity in the industry. At the present time there is comparatively little coal bought upon B.t.u. specifications, for sellers are reluctant to start again on the old basis. Besides this, lower-grade coals with higher ash contents are coming into the market.

Powdered coal may, however, change this situation. Where drying with waste gases is practiced, the usual variations in moisture offer no serious problem. Increased ash increases grinding costs only slightly and causes no further difficulty in properly constructed and cooled furnaces. Sulphur is no serious problem and merely increases grinding costs slightly. In other words, the efficiency of the pulverized coal furnace is little affected by those factors. This has been confirmed

by the ability to shift readily from one type of fuel to another with powdered fuel.

From the foregoing statement it would appear that the buyer of coal for pulverized-fuel furnaces is interested mainly in B.t.u. values in his fuel, within certain limitations. Such being the case, he is less interested in locality of mine and class of coal than formerly. He should, therefore, be in a position to buy any fuel at so much per million B.t.u. delivered at his works. This would prevent any excessive ash being included, for the seller pays the freight rate and cannot afford to ship rock and slate. The purchaser can enter the open market and buy to the best advantage, feeling assured that any of the coal offered to him can be burned efficiently. The use of pulverized fuel thus offers certain new possibilities in the coal trade and suggests the return to the B.t.u. basis for purchasing coal.

Does Cost Go up with Pressure?

IF IT proves to be true, as predicted by certain engineers in close touch with the newest developments, that steam pressures can be raised as high as 1,200 pounds without increasing the investment for a given capacity, the case for the early and general adoption of high pressures will be greatly strengthened. The gain in over-all efficiency by raising the pressure is freely admitted, but engineers are constantly cautioned to remember that *dollar efficiency* rather than B.t.u. efficiency must be the final criterion in any sound design. This is unquestionably the correct attitude, but it should not be assumed without proof that the thermal gain from the use of very high pressures will necessarily be offset even in part by increased first cost.

The statement was recently made by Eskill Berg at a meeting of the Franklin Institute in Philadelphia that a power plant designed to operate at 1,200 lb. pressure should cost little if any more than a high-grade plant built for normal present-day pressures. The first item to be considered in this connection is the boiler. The opinion was expressed by Mr. Berg and confirmed by a boiler manufacturer's representative, that the steam pressure could be raised to 1,200 lb. without increasing the total cost of the boilers. This may at first seem surprising in view of the fact that such boilers, as at present designed, require huge seamless drums perhaps four inches thick, hydraulically forged from a pierced ingot. Such drums are admittedly very expensive to manufacture. It is also admitted that such boilers must cost considerably more on the basis of boiler capacity. The saving comes in the fact that the increased plant efficiency permits a reduction of about twenty-five per cent in boiler capacity.

The greater strength necessary in piping, valves and fittings is largely offset by the much smaller sizes possible with the dense high-pressure steam. The turbines in the high-pressure plant cost more, but this in turn is offset by a considerable reduction in the necessary condenser capacity. This is evident when it is considered that the condenser is merely a device to get rid of the largest batch of heat rejected in the cycle. It is exactly by reducing the amount of heat rejected at this point that higher pressures decrease the fuel consumption. Less heat to be rejected means a smaller apparatus to accomplish it.

If the prediction comes true and the entire station cost is no higher for the higher pressures, then the question of *dollar efficiency* answers itself except in the rather intangible elements of reliability and continuity of service which, of course, have a considerable money value. In such a case the general adoption of high pressures would follow closely on the heels of practically demonstrated reliability. Such demonstrations (or the reverse) will doubtless be made during the next two or three years.

Caustic Embrittlement

THAT nascent hydrogen will penetrate and cause embrittlement of steel plate has long been known and acknowledged, but the conditions under which this may take place has been a matter of contention for some time. Hence the recent investigation by Messrs. Williams and Homerberg into the action of caustic soda on boiler steel, as reported in this issue, may be regarded as another chapter on the subject and as amplifying and confirming certain theories of previous investigators.

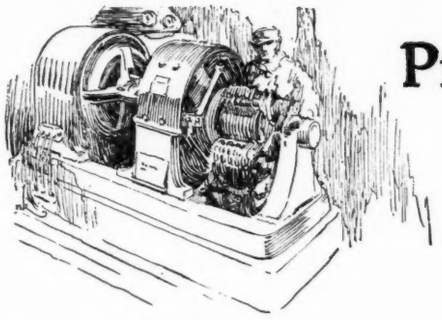
Many readers will recall the interest created back in 1910 by the paper of Commander Lyons, U. S. Navy, who pointed out that it is possible to eliminate corrosion due to acid and to oxygen by employing a three per cent normal solution of Navy compound. This practice was followed in the Navy for some time, but was later discontinued owing to the injurious results from relatively high concentration within the boiler. Babcock's paper before the A.S.M.E. in 1915 related some of these experiences and pointed out that caustic soda results from the use of soda ash, under steaming conditions, and liberates nascent hydrogen that attacks the steel causing embrittlement and cracks extending from the rivet holes outward.

The present investigation, made under stress conditions, affords an explanation of some of the previous contentions by showing that the free hydrogen attacks the oxides and sulphides of the impurities in the steel, producing voids which increase the brittleness of the material and, by the formation of steam or water pockets, augment the existing stresses and produce cracks. Various concentrations were used in the investigation, many of which were higher than generally used in treating water, although some of them were comparable with the concentrations found within the boiler.

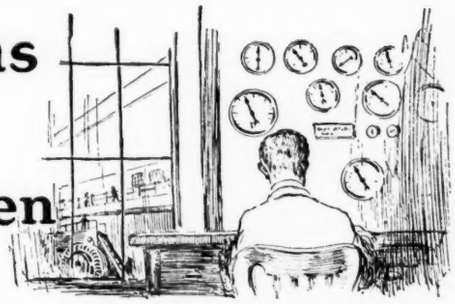
While it has apparently been proved that nascent hydrogen may be liberated by soda treatment and attack the metal, there is nothing in the present investigation to prove that such treatment is alone responsible or to confirm or disprove the findings by Fuller, as reported in a paper before the American Electrochemical Society in 1919, that hydrogen might be liberated with the use of untreated water.

Out of the maze of conflicting opinions and interests concerning Muscle Shoals comes a suggestion from the civil engineers that a commission be appointed to study the situation and formulate plans by which sale or lease of the plant may be placed on an open competitive basis. This constructive proposal fits in with the recommendations contained in the President's message.

The attempt to replace Arthur P. Davis, successful engineer, as Director of the Reclamation Service, by Dave Davis, "business man" and politician, as Commissioner of the Reclamation Service, evidently did not WORK.



Practical Ideas *from* Practical Men



The Use of Superheated Steam in Power Generation for Wood-Pulp and Paper Mills

The paper and wood-pulp industry is no doubt the third largest user of power. It is exceeded as a power user only by the blast-furnace and carbide of calcium industries. Recent census figures show that of the total power used in the paper and wood-pulp industries in the United States, 58 per cent was water power and the remaining 42 per cent steam and electric power.

The cost of power is an important factor in the manufacture of paper. This is best illustrated by the fact that about five horsepower is required for each $1,000 value of finished product or about two horsepower for each $1,000 invested.

Experience has shown that mills that drive their paper machines by water or electric power and use live steam for the drying of the paper, use about as much coal per ton of paper as those that are driven by steam engines and use the exhaust steam for drying; that is, provided the steam plant is operated at fairly high efficiency.

In paper mills the load is a variable one and the choice of the driving unit requires considerable thought. When considering the unit, due thought must be given to: The power capacity of the apparatus to be driven; speed conditions and limitations; steam pressure and temperature conditions; use or application if any of the exhaust steam; operating conditions, including consideration of vibration, attendance, starting, oiling, stopping; relative space required and relative cost of the complete installation.

It seems to be an established engineering custom that for general power uses in and about the mills a turbo-generator be employed to develop current for the operation of the various motors. However, for the direct operation of the paper machines, in my opinion, steam engines are better.

In the boiler rooms water-tube boilers with stokers or oil-fired furnaces are generally used on account of the general labor conditions and the necessity at stated intervals to carry large overloads.

The power requirements for the paper machines is a complex one, and a number of items have to be taken into account if a power unit is selected to properly meet the existing conditions. The main requirement of the power generator is that it supply the necessary power to operate the machine and also supply enough steam to dry the paper produced by the machine. To illustrate, when the paper leaves the last press roll and goes to the first drier, it contains about 68 per cent moisture. The important feature of removing its moisture from the paper is that at the beginning of the drying the heat must be applied gradually, otherwise the paper will cockle. So what is actually required is a large volume of steam at a low pressure. For instance, on a modern high-speed news machine the pressure in the first few driers is only about 4 lb. gage, while at the last few driers near the calender end there will generally be found a vacuum. In the machines making heavy cardboards, pressures of around 20 lb. are carried in the driers near the press end.

From the foregoing it will be seen that the most economical method of operating a paper machine is to have a power unit that will generate sufficient power to operate the machine and supply sufficient exhaust steam at the desired back pressure for the drying of the paper produced by the machine; for if the power unit does not supply enough steam, it is necessary to supply live steam by means of a reducing valve to the driers, so the logical method is to let the power unit act as the reducing valve and thereby obtain the motive power for little cost. In general it can be said that the ordinary weights of papers require about 3½ lb. of steam to dry 1 lb. of paper, while the heavier weights of paper require about 7 lb. of steam to dry 1 lb. of paper.

The problem of obtaining economical operation in the power plant of the paper mills is no different from that of any other power plant, but the paper mills have as a whole overlooked one means of improving the efficiency of their plants, and that is by the use of superheated steam.

In general it can be said that the use of superheated steam will effect fuel savings of from 12 to 15 per cent due to the following reasons: Improvement in the boiler efficiency; elimination of pipe-line condensation; the reduction of cylinder condensation; the decrease of maintenance costs, and by increasing the capacity of the plant.

There is in the wood-pulp mills an opportunity to use superheated steam to a good advantage and that is in the sulphiting process. For instance, in cooking the chips in the sulphuric-acid solution, it is common practice to blow steam of 80 lb. pressure into the mixture and by this method cook the chips for a period of eight hours. During this cooking process a gas is formed, and this gas is led back to the acid supply and reclaimed. There is no doubt that superheated steam will speed up this process and also that a larger amount of the sulphuric acid will be reclaimed, for when saturated steam is used for boiling, a large amount of water is blown into the solution, and this weakens the concentration of solution. However, when superheated steam is used, less steam is required to obtain the same heat effect and also the moisture usually present in saturated steam is eliminated, and these items make it possible to keep the concentration of the liquor at a higher point.

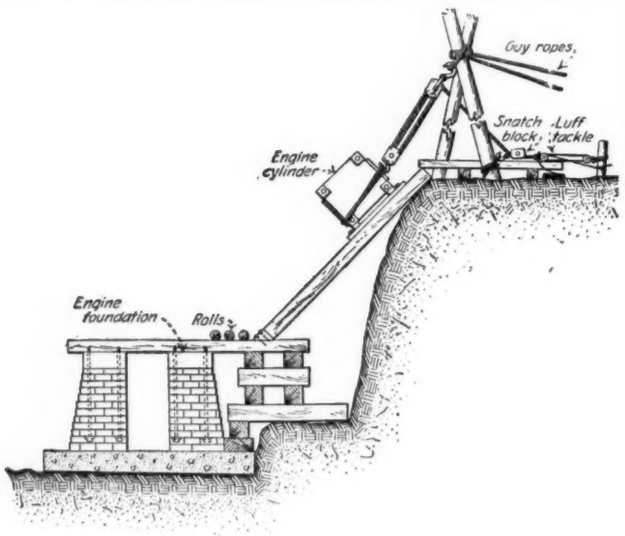
In the future it seems likely that superheated steam will rapidly replace saturated steam in existing plants and that its use will be standard practice in all new installations. J. D. MORGAN.

New York City.

Engineers as Riggers

To engineers inexperienced in handling heavy machinery in difficult positions, this article may be useful.

A cross-compound engine of 300 hp., was to be erected as auxiliary power in a water-power plant in Maine. The foundation had been built outside the mill,



How the engine parts were lowered to the foundation

the intention being to build a house over it later. The foundation top was some 15 ft. below the bank on which the engine parts had been landed. Timber and blocking were to be had, but no power was available for lowering the several parts of the engine to the foundation.

The cut shows the method employed in lowering one of the cylinders by hand. A strong stake was driven firmly into the ground and a luff-tackle attached to the hauling part of the main falls. The hauling part of the luff-tackle was snubbed around the stake. To "fleet" the tackle, a stopper was put on the main falls at the snatch-block, until the tackle was run out and a new hold taken. By this means all the parts of the engine were safely lowered to the foundation.

Utica, N. Y. M. M. BROWN.

Net Head Indicator for Waterwheel

To indicate the headwater elevation, tailwater elevation and net head on a waterwheel, a gageboard was installed as shown in the sketch. The double-runner horizontal waterwheel is set in a concrete penstock. To the side of this penstock, a 6-in. pipe was strapped, the lower end of which extended five or six feet below the normal tailwater level. Within this pipe was placed the tailwater float, which was a pine stick 5 in. in diameter and about 18 in. long. The headwater float was a pine block 7 in. in diameter and about 6 in. long. These dimensions were determined upon as just balancing the weights attached to the floats. The headwater float operated in the 8-in. vent pipe of the penstock, and this pipe also extended some four or five feet into the water. The purpose of this was to minimize the effect of ebullition of the water so close to the wheel. An iron strap was welded across the bottom of the vent pipe to prevent the float from getting caught in the wheel in case its cord should break. Both these floats were connected as shown, through sash cords and pulleys to the indicators.

This particular installation was made on the end water-wheel in a pulp mill containing ten other wheels. Owing to an obstructed tailrace the tailwater level at the draft tube of this wheel was about three feet higher than at the wheel at the opposite end. The loss through the racks varied from three to eight inches, so by comparing the indications of this gage with the other gages in the mill, an accurate check was kept at all times of the condition of the racks and tailrace, without necessitating individual measurement.

Referring to the sketch, pointer *P* indicates on the movable scale *NH* the net head on the turbine at all

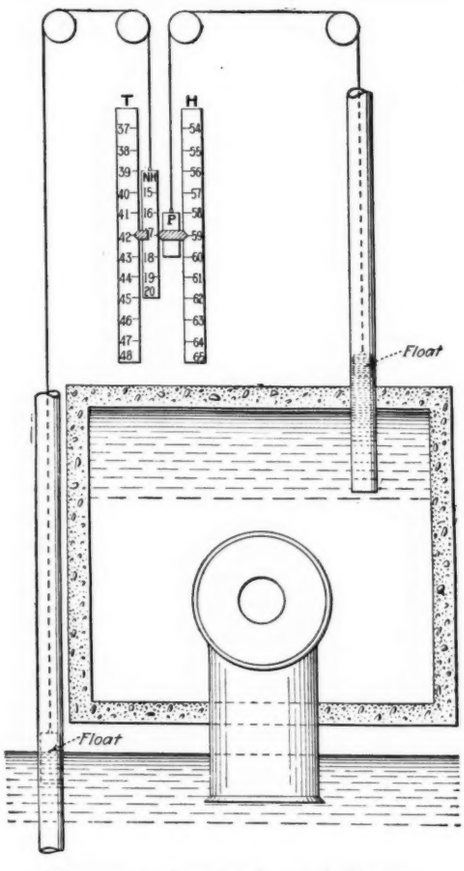


Diagram of water-level indicator

times. Since the turbine operated at full-gate opening at all times, it was possible to calibrate this scale directly in kilowatts, this being an advantage in enabling the operator to know the load on the unit without going to the switchboard, which was in another building some distance away.

The pointer and movable scale moved up and down on guides made of wire staples running in grooved boards. These grooves were kept well greased, and no trouble was experienced from excessive friction. The installation proved quite satisfactory.

Akron, O. E. J. DEL VECCHIO.

Comments from Readers

Chasing Bubbles in a Boiler

Referring to the article in the Feb. 19 issue, entitled, "Chasing Bubbles in a Boiler," while the circulation proved to be as described for the conditions under which the test was made, I believe that the circulation will depend to a large extent on furnace and setting conditions.

For instance, I once took charge of a plant in which the boilers were set low, being only about 30 in. above the grate, and at cleaning out time the loose scale would be found accumulated at the front end of the boiler, sometimes to such an extent that it was difficult to knock in the front manhole plate. Besides the scale at the front end, the rear tube sheets were very dirty. This would seem to indicate that the path of the circulation of the water was according to the popular idea; that is, upward at the front head, backward on the surface, then downward at the rear, and forward along the shell at the bottom.

The boilers were later raised to 48 in. above the grates, and the heating system was remodeled, so that the condensation instead of going to the sewer, was returned to the boilers. Now, the loose scale is found near the rear of the boiler, and any oil that does get into the boilers, instead of, according to the popular idea, uniting with the scale-forming matter, sinking to the bottom and sticking to the shell, attaches itself to the shell at and above the water line in the form of a paste and also forms a light fluffy substance and sticks to the front head and angle stays.

This is conclusive proof, I believe, that the path of circulation in the boilers in question is neither according to the real facts, as described in the article previously referred to, nor according to the popular idea, being exactly the reverse of the latter.

As to whether the water loops the loop at any point in the boiler, there is no evidence; in fact, the evidence is all against such a hypothesis.

In these boilers the circulation has been apparently reversed, and the only change that was made was to increase the distance between the shell and the grate.

As the heat transfer by radiation varies inversely as the square of the distance, and also, according to Stefann and Boltzman, according to the fourth power of the absolute temperature, it would appear that the ratio of transfer by radiation from the furnace had been reduced, by raising the boilers sufficiently to produce the effect described.

In the settings of these boilers the space behind the bridge wall is built up to within 30 in. of the shell, and as the furnace temperature is now much higher, there will be more heat radiated from this point than before the change was made. In view of these facts, it would seem to me that there are many things to be considered before we can say positively what the path of circulation is in any particular boiler. Each case must be considered by itself.

R. McLAREN.

Toronto, Ont., Canada.

Underfeed Stokers and Midwest Coals

I have read in the issue of *Power*, March 4, the paper presented by J. G. Worker at the Chicago section of the A.S.M.E. relative to underfeed stokers and midwest coals. He concludes that the process of combustion with underfeed stokers is due to arches. I do not agree with him. Indeed, if such arches resting on tuyeres were formed, the jets of air coming from the tuyeres would strike against these arches and then would be reflected back on these tuyeres, which would rapidly melt.

What leads Mr. Worker into error is the formation of very big lumps of coke which he has mistaken for arches. These big lumps are due to a fundamental error in the realization of the underfeeding principle, as hereafter will be explained.

If such arches resting on tuyeres were formed, how could you explain the two very bright and thin furrows or lines on each side of the retort while the fuel burning in the middle parts of the retorts seems dull in comparison to these bright lines?

The lighting of the fuel is produced by the radiation and chiefly by the contact with the burning fuel. The same phenomenon occurs as with usual grates where no arches are used. The only difference is that the green fuel, instead of being spread on the top part of the burning fuel bed, is spread at the lower part.

The big blocks, which have been mistaken for arches, are formed with all the existing underfeed stokers whatever may be the grade of coal used. Coal used with every automatic stoker is in small pieces and contains more or less moisture.

With underfeed stokers coal is forced by means of a ram into a cylinder, and then introduced into a retort under a thick fuel bed. On account of the necessary power to carry on this operation, the small particles of coal, which contain more or less moisture, are compressed and coal is forced into the retort in the shape of big compressed blocks or cartridges, as described.

The article admits that there is practically no agitation of the fuel bed. Moreover, as the forward movement of this fuel is very slow, the result is that these cartridges of compressed coal coke, forming big blocks of compact coke under the action of heat. The big blocks of coke which Mr. Worker has mistaken for arches are thus formed.

Now, compact coke is impervious to air, and when air coming from the tuyeres strikes against these blocks, the parts on each side of these blocks burn rapidly, giving the bright lines or furrows, while the remaining parts of compact coke seem relatively like dull fire.

With any type of multiple-retort stokers two very bright furrows are easily noticeable and the shape of the fuel bed in cross-section is not at all uniform as given in Fig. 1 of the article. On the contrary, the section takes the shape of a sinusoidal line with maximum thickness in the center of the retort and thin parts

on each side, which correspond to the furrows mentioned.

We feel satisfied that it is necessary to shake the fuel bed in order to eliminate the formation of these big lumps. Yet, this shaking of the fuel to break up the compactness of the cartridges must be produced in the retort itself as soon as they enter, but not outside of the retort.

The problem is to prevent the formation of the large compact lumps, but not to break these when already formed. To perform the latter operation it would be necessary to use crushing devices which cannot be applied to burning fuel.

Special movements of secondary pushers or lower rams giving wave-like motion in every direction, longitudinal as well as transverse, and also a shearing effect of the fuel bed may be easily applied in each retort. These devices will produce exactly the same action as the fireman accomplishes with his slice when he breaks up the crust or lumps on a plain grate.

From these motions will result many advantages, especially a perfect porosity of the entire fuel bed; an essential condition to obtain a perfect distribution of air and consequently a perfect combustion. In addition to this advantage there will be also a reduction of air pressures, consequently great saving of the power needed for the fan, reduction of the sweeping away of the fine particles of combustible in the flues, higher furnace capacities, etc.

MAURICE RATEL.
Mansfield, Ohio.

Another Milestone in Hydraulic Turbine Design

The editorial appearing in the March 18 issue of *Power* on the subject of "Another Milestone in Hydraulic Turbine Design" cannot but call forth criticism. The statement that "less than five years ago this type of wheel had hardly passed the experimental laboratory stage" is certainly open to criticism. This statement might well read "less than five years ago no manufacturer, but that with which the writer is connected, had carried this type of installation past the laboratory stage."

The writer made his first drawings and designs of the straight axial-flow type of runner in 1913. These designs were pushed through the so-called laboratory and experimental stage in the next two years, so that by 1915, nine (9) years ago, commercial plants were being built, it being then conceded that the laboratory stage had been passed. The initial plants were so successful that additional installations were made rapidly of increasing magnitude both from the standpoint of horsepower and diameters.

The significant "five years ago" may arise from the fact that in 1919 the writer prepared a paper for the American Society of Mechanical Engineers covering this type of development.* This was presented before the society at the annual meeting in 1919, and at that time all the American turbine builders present made the discussion a very lively one with their extreme criticism.

At the time of the presentation of this type of waterwheel to the public, it was preceded by six years of experimental data and four years of commercial application described in 1919 before the A.S.M.E. as follows:

> Bearing on this point it may be stated up to date seventeen commercial runners of this type, varying from 80 to nearly 1,000 hp. in capacity, have been built or are building for a total of nine plants. Nine of these have been tested out thoroughly in place with an actual showing of characteristic speeds often over 200 (in metric system 900) under abnormal low-head conditions when synchronous speed was maintained during high water.

After the presentation of the paper and up to the time of the first installation with which the writer was not connected, there elapsed about three years.

In line with the editorial emphasis of the contrasting runner weights (100,000 lb. difference) of the Cedars and Great Falls runners, the following quotation from the writer's 1919 paper is quite significant.

> In conclusion it is probably well to outline a few of the possibilities resulting from the development of this runner. In pointing these out it is realized fully that such features as the limit of application to higher heads and possibilities of pitting can only be determined by practice. Keokuk has already been referred to as an illustration of an installation where a tremendous advantage would result from the employment of a speed of 90 or 100 r.p.m. as contrasted to one between 50 and 60. A like saving would probably be effected by using a 30,000-lb. runner made without cores and easily transported, as contrasted to one weighing 130,000 lb. and ranking among the most complicated castings ever made, in one case having to be split for transportation.

If it is true that five years ago this type of runner had hardly passed the experimental laboratory stage, the following paragraphs from the same paper might seem to be uncanny in their prophecy:

> The primary advantages which were anticipated and which have proven out in practice are as follows:
>
> (a) Lower generator cost due to an increased speed of 50 per cent and over above previous practice. This saving varies from 15 to 35 per cent of the generator cost, depending on its size and speed.
>
> (b) Lower turbine cost due to simpler runner. This averages around 10 per cent, the runner being about one-third the weight of the corresponding mixed flow type and much easier to build, either solid or with separate blades.
>
> (c) Smaller generator diameter, which means smaller power house.
>
> (d) Higher generator efficiency due to better design possible with the higher speed. This is seldom less than 2 per cent gain and may conservatively be stated to vary from 1½ to 3 per cent.
>
> (e) Greater turbine flexibility which permits the plant to give more power under flood conditions when the head is greatly reduced. This runner has an over speed of about 100 per cent as contrasted to perhaps 60 to 75 per cent for previous types. This means that its efficiency and consequently its power will not become zero until the head has been reduced to about one-quarter normal as contrasted to four-tenths or one-third normal for reaction types. This advantage lies not solely at the extreme limit of minimum head, but at all abnormal heads or speeds, as the efficiency is less affected than with the other types.

The foregoing is written in order to outline the historical facts surrounding the development and application of this type of runner, facts that are at considerable variance with your editorial. These facts in no way detract from the credit due the engineers responsible for the successful application of this type of runner to so considerable a unit as the 28,000-hp. 56-ft. head machine referred to and to those responsible for the commercial aspects of the development. This is a step, both in horsepower and head, that rivals any advance ever made in engineering development.

F. NAGLER, Engineer Hydraulic Department,
Allis-Chalmers Manufacturing Co.
Milwaukee, Wis.

*"A New Type of Hydraulic Turbine Runner for Low-Head Development." A.S.M.E., December, 1919. Vol. 41, No. 12, *Mechanical Engineering*. Life Membership Award.

Where Should the Water Be Discharged in a Return-Tubular Boiler?

I should like to make a few comments on the article by R. E. Graves in the Jan. 29 issue, entitled "Where Should the Water Be Discharged in a Return-Tubular Boiler," in which he suggests the use of a pan at the end of the feed pipe. I have found that considerable hard work can be saved on boiler cleaning by placing pans in the bottom of boiler to catch the scale.

The pans should be made in three sections about 5½ ft. long for a boiler 18 ft. in length, so they can be taken out and replaced easily and also leave space for water circulation at the ends of the boiler. They should be made in the shape of the lower half of the manhole and as wide as the manhole will permit. There should be small bolts fastened to the bottom of the pans to keep them off the bottom of the boiler so that the water circulation next to the plate will not be affected. The pans can be made of copper or galvanized iron, and a few holes should be punched in the bottom and in the ends to keep them from floating out of place when the boiler is being filled with water. I usually lay a couple of bricks in each pan to keep them in place. It has been my experience that when the boiler is taken out for cleaning, once the pans are removed very little washing is necessary.

With regard to the location of the feed pipe, it should extend down just below the bottom row of tubes at the back end of the boiler, and the back pan will keep the sediment off the boiler shell. I would rather have the feed pipe enter the boiler from the top about three feet from the back end and extend down to below the tubes than to have it enter at the front head and run horizontal to the back end, across to the center of the boiler and then down. Some engineers claim that the latter method saves fuel, but I cannot see any saving, as the heat all comes from the fuel anyway, and I do not see the necessity of the extra pipe to become stopped up.

While in the government service some years ago, I was sent to a certain town to determine the cause for blistering of the boilers. I found that the compound that was being used united with the sediment in the water and cylinder oil carried over from the heater and formed a sticky paste or putty. When the fires were banked for the night, this putty would stick to the bottom of the boilers, and upon firing up the next morning it would not circulate with the water and of course the sheets would get hot and blister.

This trouble was finally overcome by installing pans in the boiler, as previously described.

Ponca City, Okla. V. K. STANLEY.

I agree with Mr. Graves that the point at which the feed water is discharged is very important. Of course in Massachusetts we are held by a state law as to where the discharge must be, some of the requirements being essentially as follows: The feed pipe of a boiler shall have open end or ends; the feed water shall discharge about three-fifths the length of the boiler from the front head and at or about the central rows of tubes above the tubes; the feed pipe shall be carried through a bushing in the front head and securely fastened above the tubes.

The feed pipes in our boilers are installed according to the method just described, and there is little sediment on the tubes, not enough that I would want to bother with a pan or mud drum, for I think in the return-tubular boiler that it would be out of place, and in the way, while no beneficial results would be gained by using the pan. Of course in cases where the water contains a large amount of sediment, it is advisable to use a trough with a blower attached to it.

The reason that the feed pipe extends so far to the rear is that the water gets a chance to be heated to a higher temperature before discharging, thereby causing less strain on the boiler. I have thought that the feed pipe should go to the rear half, across, then back toward the front. This would heat the water still more.

Springfield, Mass. F. C. EATON.

The First Steamboat

In view of the large amount of discussion that has taken place recently in *Power* on the early Corliss engines and poppet-valve engines, the following article, which appeared in the *Halifax Chronicle* for Feb. 5 and previously in the *Ottawa Journal*, may be of interest:

In one of George Borrow's forgotten books—which, by the way, are much more entertaining than most of the books people read today—he says: "More than five hundred years have elapsed since the idea of making a steamboat first originated; but it was not until the close of the last (eighteenth) century that the first worthy of the name made its appearance on a Scottish river." One is reminded of this fact by a somewhat bombastic statement in a recent number of an American magazine, based on the idea universally accepted in the United States, and probably by a good many people elsewhere, that Robert Fulton invented the steamboat, and that the "Clermont," which made its way up the Hudson to Albany in 1807, was the pioneer vessel to be driven by steam power.

As a matter of fact Fulton was not even the pioneer in his own country, for John Fitch had experimented with a steam vessel as early as 1787 and in 1790 launched a small boat which made a speed of eight miles an hour. The previous year William Symington had a boat on the River Carron, in Scotland, equipped with engines built by the Carron Iron Works Company. The idea had, as Borrows suggests, been in men's minds for several hundred years, but for some time did not get beyond plans and models. In 1736 an Englishman, Johnathan Hulls, patented a stern-wheel towboat worked by steam; and in 1783 the Marquis de Jouffroy, a Frenchman, brought out a paddle steamboat which plied on the River Saone for over a year. So far as Fulton is concerned, it is known that he had Fitch's plans in his possession for some months, and not only saw Symington's boat in operation, but got from him full details of his engines. The engine of the "Clermont" was made by Boulton & Watts in England. It is a matter of history that a committee of the New York legislature decided that the steamboat built by Fulton was in substance the invention patented by Fitch in 1791.

Similarly, it has been repeatedly claimed that the "Savannah," an American vessel, was the first steamboat to cross the Atlantic. The "Savannah" sailed from New York to Liverpool in 1819. As a matter of fact, the "Savannah" was a full-rigged sailing ship equipped with a small steam engine and paddle-wheels. Her logbook shows that in a total voyage of 707 hours her engines were used for only 80 hours. She sailed nearly all the way across and did not use her engines at all on the return trip. The first vessel to cross the Atlantic under steam was undoubtedly the "Royal William," built in Quebec in 1831. Her engines were made by the same English firm that equipped the "Clermont." She crossed to London in 1833, entirely by steam power, and was afterward sold to the Spaniards, who converted her into a warship, so that she also became the first steam-driven war vessel. Eight years earlier two little English ships, the "Falcon" and "Enterprise," made a much more adventurous voyage, sailing from England to India around the Cape of Good Hope. On the whole, the British Empire can claim a pretty generous share of the honor of leading the way in steam navigation.

Halifax, N. S., Canada. PHILIP A. FREEMAN.

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Test of Boiler Safety Valve

How should a test be made to determine whether the discharge capacity of a safety valve is sufficient?

R. L. B.

The safety-valve capacity may be checked by making an accumulative test which should prove that the valve is capable of discharging all the steam that can be generated by the boiler under most favorable fuel, fire and draft conditions, without allowing the pressure to rise more than 6 per cent above the maximum allowable working pressure or more than 6 per cent above the highest pressure to which any valve is set.

Heating Surface of Standard-Weight Wrought-Iron and Steel Pipe

What is the number of square feet of heating surface per linear foot and the number of linear feet required for one square foot of heating surface of ¾- in. to 6-in. standard steel and wrought iron and steel steam pipe?

F. M. L.

The outside dimensions and external surface of welded wrought iron and steel pipe of nominal inside diameters, ¾ in. to 6 in., and the external or heating surface per foot and number of linear feet required to contain one square foot of heating surface are as follows:

Nominal Size Internal Diameter in Inches	External Diameter in Inches	Sq.Ft. of Heating Surface per Ft. Length of Pipe	Length of Pipe in Ft Per Sq.Ft. of Heating Surface
¾	1.050	0.275	3.636
1	1.315	0.344	2.904
1¼	1.660	0.434	2.301
1½	1.900	0.497	2.011
2	2.375	0.622	1.608
2½	2.875	0.753	1.328
3	3.500	0.916	1.091
3½	4.000	1.047	0.955
4	4.500	1.178	0.849
4½	5.000	1.309	0.764
5	5.563	1.456	0.687
6	6.625	1.734	0.577

Heat Exchanger for Tropical Oil-Engine Plant

Diesel engines are proposed for an installation in a tropical locality at which conditions are unique. Fresh water can be obtained only by distillation from sea water, the temperature of which at times reaches nearly 100 deg. F. Is it practicable to use a fixed quantity of fresh water for cooling the jackets and to cool this by circulation through an ordinary marine surface condenser? Assuming fresh water to jackets 110 deg. F. from jackets 140 deg., sea water to condenser 100 deg., from condenser 130 deg., what size condenser would be required for a 500-b.hp. engine? *C. L. E.*

The amount of heat thrown off to the cooling water will be approximately 10 per cent more than the amount converted into work; that is, 1.10 × 2,545 = 2,800 B.t.u. per indicated horsepower. With a mechanical efficiency of 90 per cent each brake horsepower entails the absorption of 2,800 ÷ 0.90 = 3,111 B.t.u. per hour by the cooling water, which for a 500-hp. engine amounts to 1,555,500 B.t.u. per hour.

In arriving at the amount of condenser or cooling-coil surface necessary to cool the jacket water from 140 to 110 deg., it is necessary first to find the mean temperature difference between the jacket water and the raw water, the latter entering at 100 deg. and leaving at 130 deg. With these values under which the temperature difference is the same at entrance and exit, the arithmetical temperature difference is used, this being

$$\frac{(140 - 130) + (110 - 100)}{2} = 10 \text{ deg. F.}$$

The coefficient K for heat transfer between water and water will range from 50 to 75 B.t.u. per sq.ft. per degree temperature difference per hour.

The formula for heat transfer is $H = KTA$ and substituting the values found we have

$$1{,}555{,}500 = 50 \times 10 \times A$$
$$A = 3{,}111 \text{ sq.ft.}$$

The problem as stated contemplates the circulation of the same amount of sea water as jacket water. This, it will be observed, calls for a large condenser, by reason of the small temperature difference between the two liquids. By circulating enough water to bring the raw-water discharge to, say, 110 deg., the temperature difference is larger and the cooling surface smaller. On the assumption that the temperatures are: Jacket in, 140 deg.; jacket out, 110 deg.; sea water in, 100 deg.; sea water out, 110 deg.;
the mean temperature difference will be

$$\frac{(140 - 110) - (110 - 100)}{\textit{hyperbolic log}\ \frac{140 - 110}{110 - 100}} = 19 \text{ B.t.u.}$$

The square feet of surface A becomes 1,555,500 ÷ 50 × 19 = 1,637 sq.ft.

The system of using raw water to cool the jacket water is coming into general use in this country and proves satisfactory. There is no reason why an ordinary shell-type marine condenser could not be used, but in practice a set of coils similar to the atmospheric ammonia condenser is preferred. The raw water in dripping from one coil to another is cooled to a marked extent by the air through evaporation; on account of this, the square feet of pipe surface need not be over one-half that given herein.

Remelted Babbitt Metal

Is remelted babbitt metal as good for bearings as new babbitt? *C. D.*

Scrap babbitt is likely to contain injurious gritty and other foreign matter which cannot be entirely removed by remelting. From repeated remelting the mixture loses fluidity, becomes "mushy" and will not make as sharp, smooth and solid castings as when the alloy is first compounded from virgin metals. This probably is due to separation of some of the ingredients when the temperature is only high enough for fusion of others having lower melting points.

Measuring Angle of Advance of Eccentric

How can I measure the angle of advance that the eccentric has on a Corliss engine? *L. R. W.*

The eccentric radius will make an angle of practically 90 deg. with the direction of the stroke of the engine when the wristplate is at the middle of its travel. As the angle of advance of the eccentric is the number of degrees the eccentric is more than 90 deg. ahead of the crank, it follows that when the wristplate is in central position, the crank will be as many degrees behind its dead center position as the angle of advance. But if the angle of advance is negative, that is, if the eccentric is less than 90 deg. ahead of the crank, as required of the steam eccentric of a double eccentric Corliss engine for the purpose of obtaining cutoff after ½ stroke, then, when the wristplate arrives at mid-travel, the crank will be as many degrees ahead of its dead center position as the negative angle of advance.

For measuring the angle of advance, make a mark on the crosshead to correspond with a mark on a guide when the piston is in the crosshead end of the cylinder with the crank on dead center. With the wristplate hooked up to the eccentric rod, make pencil marks on the wristplate stud to correspond with the central mark on the wristplate hub when, by turning the engine over, the wristplate is carried as far as it will go first to one side and then to the other, and make a mark on the wristplate stud midway between those marks to locate where the central mark on the wristplate should arrive when the eccentric radius is at an angle of 90 deg. with the direction of stroke.

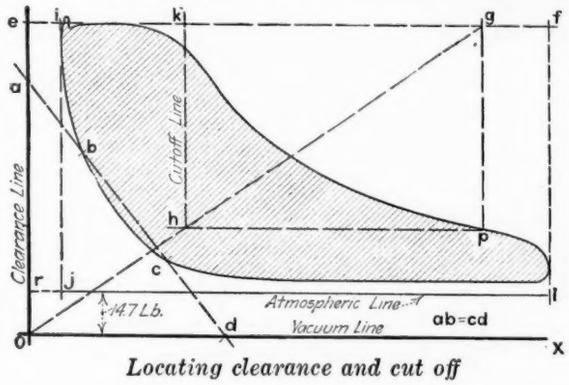
Then beginning with the piston at about ¾ stroke from the head end, turn the wheel forward until the crank is on the crosshead dead center. If the wristplate has not been carried to the midposition, the angular advance of the eccentric is negative; if brought up to the midposition it is 0, and if carried beyond the midposition the angle of advance is positive.

If negative angle of advance is to be measured, having the crank still on dead center, make a mark on the flywheel at one edge of the rim, to correspond with a mark on a stationary object placed close to the same part of the rim. Then turn the wheel forward until the mark on the wristplate comes opposite to the middle mark that was made on the wristplate stud and make another mark on the rim of the wheel at the mark on the stationary object. With a tape line measure the circumferential distance, mark to mark on the rim, and also measure the complete circumference of the same part of the rim and, for greater accuracy, reduce the rim measurements to eighths of an inch. Degrees of negative angular advance then will be 360 × distance between marks ÷ circumference of the wheel. If the angular advance was found to be positive from the fact that the wristplate was carried beyond its mid-travel when the crank was brought up to dead center, then beginning again with the piston at about ¾ stroke from the head end, turn the wheel forward until the wristplate comes to the middle of its travel; make a mark on the edge of the wheel to correspond with a mark on a stationary object close to the rim; turn the wheel forward until the crank comes into dead center; and make another mark on the rim to correspond with the mark on the stationary object. Then (with measurements properly reduced to eighths of an inch) number of degrees positive angle of advance will be 360 × circumferential distance between marks ÷ circumference of the same part of the wheel.

Determining Clearance and Point of Cutoff from Diagram

How can clearance and true point of cutoff be determined on an indicator diagram? *W. L. G.*

The method of determining the location of the cylinder clearance from the compression line of the diagram and the theoretical point of cutoff based on the position of a point in the expansion line, are indicated in the figure. According to the scale of the diagram, draw the vacuum line *OX*, 14.7 lb. below the line of atmospheric pressure. Draw straight line *abcd* across the compression curve, intersecting *OX* at *d* and from *b* lay off $ab = cd$. Through *a* draw *a O* perpendicular to *OX* and this will be the clearance line. Draw *ij* and *fl* tangent to the ends of the diagram and perpendicular to the atmospheric line. Then as *jl* represents the volume of piston displacement and *ei* or *rj* represents the clearance volume, the percentage of clearance would be *rj* × 100 ÷ *jl*.



Locating clearance and cut off

For determining the true point of cutoff, draw *ef* parallel to the atmospheric line to represent the initial pressure. Then, selecting any point *p* in the expansion curve, preferably near the point of release, erect perpendicular *pg;* draw the diagonal *gO* and from *p* draw *ph* parallel to the atmospheric line intersecting *gO* at *h*. Through *h* draw the vertical line *hk* and this will be the cutoff line. The theoretical point of cutoff for the assumed initial pressure and point *p* of the expansion line will be at *k* and the percentage of cutoff will be *ik* × 100 ÷ *jl*.

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Here and There in the Power Plant

Sidelights on things generally used but less generally understood

Is Algebra Worth While?

PROFESSOR Sweet used to tell a story about his boyhood school days. It seems that the future professor did not make much of a showing in his school work. In fact, he disliked it very much, with the one exception that arithmetic appealed to him. His teacher, perceiving this fact, plotted to use it to interest him in algebra. "Let A represent 300," she began, but young Sweet broke up the show at the very start with the remark, "Why not represent 300 by three and two noughts?" He was right. If algebra were nothing but ordinary arithmetic with letters used instead of numbers, its field of usefulness would be limited. The question then arises, Just what is algebra and of what practical use is it to the operating engineer?

Algebra More Than Arithmetic with Letters for Numbers

Algebra is something more than a system of replacing definite figures by letters. It permits the working out of a whole group of arithmetical problems as a single problem. What this means can be made more clear by an example. Suppose we know the rule that the area of a circle is equal to the product of 3.1416 by the square of the radius. If the radius of the circle is given in each case, this rule is in its simplest form and algebra can be of no assistance in obtaining the area. Where, on the other hand, the diameter is customarily given instead of the radius, the rule becomes clumsy, it being necessary in each individual case to divide the diameter by 2 to get the radius before applying the rule. While this is a simple process, it means much additional labor if carried out hundreds of times. By working out a single algebraic problem, this division can be accomplished once for all.

First write the rule in the form of the equation

$$a = 3.1416\ r^2$$

Where a = area and r = radius. Since the radius is equal to one-half the diameter we may write $r = \frac{d}{2}$. If one quantity is equal to another, it may be substituted for the other in any equation. Putting $\frac{d}{2}$ in place of r in the first formula, gives

$$a = 3.1416 \left(\frac{d}{2}\right)^2$$

The first step in simplifying this is to square the fraction $\frac{d}{2}$ as indicated. This is done by squaring the numerator and denominator, giving $\frac{d^2}{4}$. We then have:

$$a = 3.1416 \frac{d^2}{4} = \frac{3.1416}{4} d^2 = 0.7854 d^2$$

Now suppose it is desired to determine the area in square feet of a number of circles whose diameters are to be measured in inches. With the rule just derived, and using only arithmetic, it would be necessary to figure the area of each circle in square inches and then divide each of these areas individually by 144 to get the corresponding areas in square feet. If there is more than one such area to determine, this is a waste of time. The division can be performed once for all in the algebraic equation.

Let A = area in square feet.

Then $a = 144\ A$, since an area in square inches is 144 times the same area in square feet. Replacing a in the last formula by its equivalent, 144 A, we have

$$144\ A = 0.7854\ d^2$$

The next step is to solve this equation for A; that is, get it into a form where A stands by itself on the left-hand side of the equality sign. Most simple algebraic equations can be solved by the use of the following six self-evident laws:

Six Useful Laws

1. If equals are added to equals, the results are equal.

2. If equals are subtracted from equals, the results are equal.

3. If equals are multiplied by equals, the results are equal

4. If equals are divided by equals, the results are equal.

5. If equals are raised to the same power (square, cube, etc.), the results are equal.

6. If the same root (square root, cube root, etc.) is taken of equals, the results are equal.

In this case it is evident that if the left side of the equation is divided by 144 it will reduce to A as desired. Rule 4 shows that if the right side is also divided by 144 at the same time, the two sides will still be equal. We may therefore write

$$A = \frac{0.7854}{144} d^2$$

To bring this to its simplest form the fraction $\frac{0.7854}{144}$ must be reduced to a decimal, dividing 0.7854 by 144. This gives 0.005454, and the final formula becomes

$$A = 0.005454\ d^2$$

Having derived this simplified formula, it is only necessary to square each diameter (measured in inches) and multiply by 0.005454 to get the area directly in square feet. For example, a diameter of 9 in. would give an area of $0.005454 \times 81 = 0.4418$ sq.ft.

Getting Diameter from Area

Now suppose it is required to get a formula that will give directly the diameter in inches when the area is given in square feet. This can be done by working the given formula around so that d stands alone on the left-hand side.

First we may write $0.005454\ d^2 = A$, which is obviously true. The next step is to get the 0.005454 away from the left-hand side. Rule 4 shows that this can be done by dividing both sides of the equation by 0.005454, giving

$$d^2 = \frac{A}{0.005454}$$

The next step is to remove the square sign from the d. To do this take the square root of both sides according to Rule 6. This gives

$$d = \sqrt{\frac{A}{0.005454}}$$

The formula would be fairly usable in this shape, but it can be put in a still more convenient form. The fraction $\frac{A}{0.005454}$ is the same as $A \frac{1}{0.005454}$ or 183.35 A. So the formula becomes

$$d = \sqrt{183.35\ A}$$

Now the square root of the product of two numbers is the same as the product of their square roots, so we may write

$$d = \sqrt{183.35} \times \sqrt{A}$$

Since $\sqrt{183.35} = 13.54$, this reduces to $d = 13.54\ \sqrt{A}$.

This is the simplest formula for obtaining the diameter in inches directly from the area in square feet. Where a number of such problems have to be solved, the labor of deriving the formula is amply repaid.

The examples shown are of the very simplest nature, but they illustrate the practical application of algebra, which lies in the fact that it makes possible a general solution of all problems of a given class, the final algebraic answer being in the form of a simplified formula that can be quickly solved for any particular case.

The engineer who does much figuring of areas, volumes, etc, without knowing a little algebra, inevitably wastes a lot of time in entirely unnecessary operations.

Refrigeration in the Manufacture of Steel

By H. J. MACINTIRE

It is not generally understood that refrigeration has a part in the manufacture of steel. However, the Gayley dry-blast process has been used for some time in the United States and in Europe, although the process has not become general nor have any new plants been installed of late years. At the present time refrigeration is used mainly in tempering and hardening, and either refrigerated oil, water or brine is used to extract the heat from the hot metal, the quenching liquid depending on the quality of steel being produced. For example, all alloy steels use cool oil only, while plowshares and mold boards, requiring extreme hardness, use brine cooled to about 45 deg. F.

The Gayley dry-blast process was developed some twenty years ago. It consists in cooling the air going to the furnace to a dew-point temperature of 25 deg. F. at atmospheric pressure, at which time the moisture content is 19.5 grains per pound of dry air. The claims made for the process are that the furnace can work with greater regularity and that a reduction of 12½ per cent in the fuel required and a gain in 10 per cent in the production of the furnace are possible by its use. The reason advanced for this phenomenal gain in economy is that the moisture in the air, which at times may be 150 grains per pound of dry air, chills off the fire just when a hot fire is required, by the chemical action of breaking the water vapor into oxygen and hydrogen. The result of this endothermic reaction is that there is not the proper removal of the sulphur or the proper deoxidation of the silicon during warm, damp weather unless there is additional heat provided in the furnace by the addition of extra coke.

In the blast furnace it is necessary to use large blowing engines in order to compress the air required for supporting the combustion being carried on in the furnace, and the blast may be at some pressure between 15 and 30 lb. gage, and the compressed air is made to pass through checkerwork, previously heated by the exhaust gases from the furnace, until the blast temperature has become nearly 3,000 deg. F. The refrigeration has been provided as a rule on the suction side of the blowing engine, and therefore under these circumstances it will take place at atmospheric pressure. The air cooled to 25 deg. F. so that its low moisture content becomes 19.5 grains per pound of dry air, is then passed to the compressor, which is reduced in size thereby, on account of the increased density of the air.

The manner of cooling of the air at the Isabella works of the Carnegie Steel Co., which, however, has not been operated since 1910, was to have two large bunker rooms with ammonia direct-expansion piping in each, but so arranged as to permit the air passing through one and then the other of these rooms by the operation of large butterfly valves. The reversal of directional flow permitted the frost accumulation on the pipes to melt off in a manner similar to the present-time dehydrator of high-pressure air for can-ice agitation. Since 1912 the design of air cooling has changed decidedly so as to use the principle of the cooling tower or scrubber, arranged with tile wetted with water in the first stage and by brine in the second stage. Later came the design using spray nozzles. In this case the air is compressed by the blowing tubs first, and in consequence of the higher pressure the air does not have to be cooled as low in temperature to secure the same weight of water content. For example, by compressing the air to 20 lb. gage it is necessary to cool the air down to 46 deg. F. to obtain the same weight of moisture (19.5 grains) as would be secured by cooling the air at atmospheric pressure to 25 deg. F. In this case water can be used in the spray nozzles for the entire cooling action, and there will not be any requirement of reconcentration as there would be in the case of brine. Compressor operation is more economical because of the higher refrigerating temperature being carried. The dry-blast process is, however, very expensive in first and operating cost, and other improvements in furnace design and operation have reduced the original gains in economy to about one-third of the amount stated. The result is that no new installations of the dry-blast process have been made of recent years.

Refrigeration is also used in chilling steel by cooling the oil, brine or water required by the special steel specification. For example, mold boards and plowshares require very hard tempering and use brine cooled to about 45 deg. F., the sodium-chloride brine being preferred to water because of the more uniform cooling over the surface and the more rapid heat transfer. Quenching oil which has been refrigerated to about 50 to 60 deg. F. is used on steels requiring a lesser degree of hardening.

Coal Versus Oil

In a paper presented before the Boston Wholesale Coal Association, on Feb. 13, Prof. E. F. Miller, of the Massachusetts Institute of Technology, discussed the fuel problem with particular reference to the relative advantages of coal and oil for the New England district. The following digest covers some of the points brought out by Professor Miller.

In designing a power plant, many factors affect the choice between coal and oil fuel. For example, the location of a plant 200 miles from tidewater would tend to favor coal because of the extra cost of shipping fuel oil by rail. On the other hand, low load factor might favor oil even where it costs considerably more per heat unit.

Until recently a higher thermal efficiency has generally been obtainable with oil than with coal. Today there is not much difference when operating under good load conditions.

Where a plant runs steadily at about 125 per cent of rating, practically the same efficiency can be obtained with stokers as with powdered coal, but this condition is rarely attained in practice. Variable loads and banked fires favor powdered coal or oil. Powdered coal will handle a bigger range of fuels than will a single type of stoker.

An easy rule for determining the amount of air theoretically needed to burn coal was worked out by the engineers at the United States government fuel-testing laboratories. This rule which may also be used for oil, follows: "*Divide the heating value of the fuel by 10,000 and multiply by 7.5.*" To the answer thus obtained perhaps 15 per cent should be added for air actually needed under good conditions.

The accompanying table gives a comparison between coal and oil. The figures are based on net efficiencies after deducting the steam used in operating stokers and fans in the case of underfeed stoker plants and the fuel and power used for drying and pulverizing in the case of powdered-coal plants. These are compared with an oil-burning plant running at 80 per cent thermal efficiency.

While it is apparent that oil has certain advantages over coal, the uncertainty of the oil supply has kept many from changing to this fuel. It is probable that much of the coal now considered fit only for the manufacture of briquets, which can be purchased at a low price, will be utilized for steam generation in the pulverized form.

ADVANTAGES OF OIL

Cost of handling much lower than equivalent amount of coal.

Saving in labor in fireroom, especially due to fact that there are no ashes to handle.

Storage space for same reserve capacity only 60 per cent that of coal and storage space may be a considerable distance from boiler room.

Freedom from bunker fires and from deterioration in storage.

Necessary chimney area only 60 per cent that required for coal.

DISADVANTAGES OF OIL

Must get oil with high flash point to avoid danger of explosion.

City ordinances may require what may seem to be unreasonable precautions against fire at storage tanks.

If not properly installed, upkeep on boilers may be greater than with coal.

COMPARISON OF COAL AND OIL

Boiler efficiency with coal (net).	0.825	0.80	0.775	0.75	0.725	0.70	0.675	0.65
Equiv. evap. from and at 212 deg. F. in lb. per lb. coal of 14,600 B.t.u.	12.412	12.036	11.660	11.284	10.908	10.532	10.156	9.779
Barrels of oil 336 lb. to bbl., 42 gals. 18,500 B.t.u. per lb.) Burned with 80 per cent net efficiency equivalent to one ton of coal	4.8443	4.6976	4.5508	4.4040	4.2571	4.1103	3.9636	3.8168
Price of oil per barrel with coal at $10 a ton for same amount of heat utilized, dollars	2.068	2.128	2.197	2.271	2.349	2.433	2.523	2.620
Price oil per gallon, cents	4.91	5.07	5.23	5.65	5.59	5.79	6.00	6.24

Model Shows Actual Flow of Water

The purpose of the guide vanes in centrifugal pumps and water turbines is to cause the water to flow in a certain predetermined manner, with the object of reducing the total loss due to skin friction and eddy currents to a minimum. The design of hydraulic equipment is so involved that designers have always been interested in checking up their assumptions by some method of observing the actual results obtained. One fairly old method of investigating stream flow is to admit at desired points fine streams of dye and observe the path that they follow.

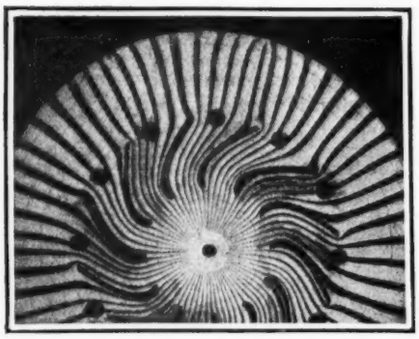


Fig. 1—Photograph of stream lines

The Dec. 22, 1923, issue of the Swiss engineering magazine, *Schweizerische Bauzeitung*, contains an article by Prof. F. Praesil, Zurich, giving the results obtained by the application of this method to a small model with radial guide vanes. Twelve vanes, each half a millimeter high, were cut from hard rubber and fixed between a white baseplate and a polished glass sheet. To make the stream lines visible to the eye, a solution of potassium permanganate was introduced into the water through sixty-four small holes drilled through the baseplate and spaced equally along the circumference of an eight-centimeter circle. A similar apparatus had previously been used by Dr. H. Oettli and described in his research work entitled, "The Movement of Water Through a Rotating Impeller."

Fig. 1 shows the photograph obtained when the dye was admitted in steady streams. In this photograph the hard-rubber guide vanes and the colored stream lines are clearly visible. No significance should be attached to the circular black dots, which are merely closed-up holes in the glass plate.

While Fig. 1 shows the direction of the stream lines at all points, it does not show the velocities. To obtain these, O. Walter, mechanical engineer and assistant in the Hydraulic Laboratory of the Erste Technische Hochschule, has modified the method of operating this apparatus in such a way that photographs will permit measurement of the actual velocities. This result was obtained by introducing the dye intermittently at regular short intervals. In tracing the resulting photograph, it is possible to draw not only the stream lines, but also curved lines representing the successive positions of particles of water starting together at the center.

Fig. 2 is a tracing made from such a photograph, the numbered lines, 1, 2, 3 etc., representing the successive puffs of dye. By measuring the distance between the time curves along the stream lines, it is a very simple matter to determine the velocity of flow at all points. This method of investigation is said to have great possibilities.

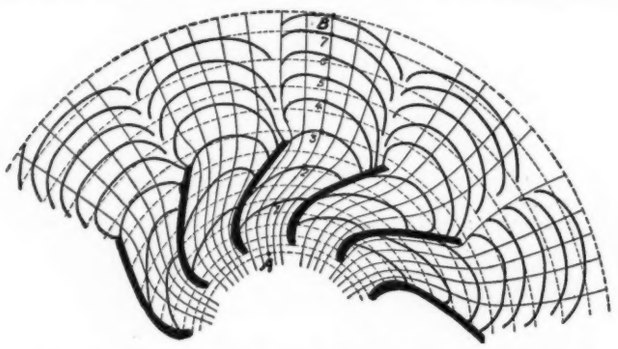


Fig. 2—Tracing of "dyestuffs" showing successive positions of water particles

Increased Size of Water-wheel-Driven Generator

In a paper, "The 65,000-kva. Generator of the Niagara Falls Power Company," by W. J. Foster and A. E. Glass, presented at the spring convention of the American Institute of Electrical Engineers, Birmingham, Ala., April 7 to 10, the authors say in part:

At the close of the Nineteenth Century a notable event occurred at Niagara Falls—the development of a plant for the utilization electrically of Niagara power. Then, as now, Niagara Falls was recognized as the finest water power in the world, a cataract of great height, fed from the five Great Lakes, constituting a water storage without a rival. It was in keeping with the situation that the first plant was developed with mammoth units, much larger than had been dreamed of up to that time. They were 5,000 hp. each, or, translated into electrical terms, 3,750 kw., eleven of these units under one roof.

Almost exactly twenty-five years later a generator with nominal rating of 65,000 kva., or one capable of 50 per cent greater output than the entire row of units in the original power house, was put into service. This latest generator is the product of the experience gained during the intervening years. It is three-phase instead of two-phase; it is 12,000 volts instead of 2,200; it is 80 per cent power factor instead of unity-power factor; it has high internal reactance instead of low; it has losses at full-rated load equal to approximately 2 per cent of its output, whereas the original had from 7 per cent to 8 per cent; it is of the "conventional," internal-revolving field type, whereas the original had its field revolving outside of the armature; it supports on its stator, by means of thrust bearing mounted at the top, the entire weight of its own rotor and the runner of the turbine, whereas the original had its revolving part supported from an oil-pressure step bearing located underneath; it is located so close to the turbine that it has no lower guide bearing of its own, whereas the original was some 150 ft. above the turbine with several guide bearings intervening; it is equipped with brakes to bring it to rest quickly, whereas the original had no means provided for bringing it to rest except the shutting off of the water to the turbine; it contains approximately twenty-three pounds of material per kilovolt-ampere output, whereas the original contained nearly fifty pounds.

Although the quantity of material in this large generator is less than a half that of the original per kilovolt-ampere, it is very large as compared with a modern 60-cycle generator of large capacity at the higher speeds that are now common in hydraulic developments. There are three reasons for this generator having such a great weight as one and one-half million pounds of material: First, the fact that it is low speed; second, it is low periodicity; third, it was designed for the highest economic efficiency.

Regarding the effect of rotative speed on weight, it may be said, that for the same electrical characteristics the lower the peripheral speed the greater the weight of magnetic material and copper, and that the lower rotative speed always requires a lower peripheral speed to obtain the proper adjustment between the material that must be used for mechanical structure and that which must be used for the electrical parts.

The stator winding consists of 360 coils weighing 186 lb. each, and the total weight of the completely insulated and connected winding is approximately 70,000 lb. The field coils are wound with copper strap 0.43 in. by 2.625 in. in cross-section, which is probably the heaviest strap ever used in field coils. In each coil the weight of copper is 2,800 lb. One field pole and its winding weight 10,900 lb. The assembled generator is 30 ft. 4 in. outside diameter and stands 26 ft. 4½ in. high from the bottom of the base casting to the top of the thrust bearing. A Kingsbury thrust bearing designed to carry a load of 1,250,000 lb. supports the revolving element, which, with the downward thrust of the water, represents a load of 1,200,000 lb.

Swasey Will Be Presented Medal on April 23

The John Fritz Medal Board of Awards, representing the A.S.C.E., A.I.M.&M.E., A.S.M.E. and A.I.E.E., will present the John Fritz gold medal to Ambrose Swasey at 8:30 on the evening of April 23, at the auditorium of the Engineering Societies Building, 29 West 39th St., New York City. Friends of the members of these societies will be welcome.

Another Offer for Muscle Shoals

An offer will be presented to the Senate Committee of Agriculture at the hearings that are to begin on April 16, for Muscle Shoals.

The bill, presented by James T. Lloyd, former representative from Missouri, is for the incorporation of the American Nitrate Corporation, which is to be managed by a board of five directors, two to be selected by the Secretary of Agriculture and three to be selected by the stockholders of the corporation. It provides: For the fixation of atmosphere nitrogen; the manufacture of fertilizer and explosive compounds; generation of electric power and the conservation of water, for power, stream control, transportation and for other purposes.

Its terms include briefly: Lease for fifty years; capital stock of $10,000,000; the Secretary of War to execute the lease; Secretary of Commerce to advertise for plans and specifications for dams, locks, etc.; engineers of United States Army, Reclamation Service, Federal Power Commission to submit competitive plans and specifications, best of any or all to be utilized; Bureau of Standards to do the testing unless other laboratories are necessary; within two years the hydro-electric plant to be equipped and ready to generate 200,000 hp.; within five years to generate 600,000 hp.; corporation to pay government as part compensation for the lease one mill per horsepower-hour for primary power generated with the river flow, the receipts of the sale of power to other consumers, exclusive of the one mill paid to the government, to be used by the corporation to meet operating and other expenses; recapture provisions.

Civilian Control Wanted

Strong resolutions demanding civilian control of all non-military engineering work of the government and opposing the proposed sale of the Muscle Shoals plant were adopted by the Board of Direction of the A. S. C. E. in Atlanta April 7 and 8, preceding the opening April 9 of the spring meeting of the society.

The board declared that the development should not be sold until full information on power, on nitrogen fixation possibilities and on costs has been collected by a fact-finding commission and that Congress should not deal with Muscle Shoals in any manner differing from the terms of the federal water-power act. It also asked that Congress give opportunity for presentation of plans by which the cost of the plant may be recovered in the shortest possible time and that Congress place the sale or lease of the plant on an open competitive basis.

Walter Neumuller Dies After Brief Illness

News of the death, from pneumonia, of Walter Neumuller, secretary of the New York Edison Co. and treasurer of the N.E.L.A. at his home in Portchester, N. Y., after a sickness of less than two weeks, came as a shock to his many friends and associates in the electrical field.

Walter Neumuller

Born in New York City June 21, 1886, he attended the public schools until the age of 14, when he became office boy for the New York Edison Co. He rose rapidly and on Feb. 17, 1920, at the age of 33, was elected secretary of the company.

Mr. Neumuller was also secretary of the Yonkers Electric Light Association; vice-president and treasurer of the New York Electrical Show Co.; director and past president of the New York Electrical League; director of the New York Electrical Board of Trade; life member and past vice-president of the New York Electrical Society; member and past chairman of the New York Companies Section of the N.E.L.A.; member of Illuminating Engineers Society and other clubs and associations of a social nature.

He is survived by a widow, two sons, his mother, two brothers and three sisters.

Federal Power Commission Without Authority

Policies looking to the maximum utilization of the power resources of streams are threatened by legal opinion of the Chief Counsel of the Federal Power Commission in which other government law officers concur. The opinion is to the effect that the commission is without authority to institute injunction proceedings against those who insist upon constructing power projects above the navigable portion of a river, and which will not affect directly the navigable capacity of the waters below.

An example of the effect of this ruling is that it precludes the commission from taking action against the town of Andrews, N. C., which has insisted on carrying forward a small power project which absolutely prevents a program for the larger use of the river's resources.

Who Should Gather Statistics?

Disparity in the figures issued by the Bureau of the Census and by the United States Geological Survey covering production of electricity at central stations has caused a renewal of discussion as to how these figures should be handled. Engineers apparently lean to the use of specialists for the gathering of such statistics. An engineer familiar with the industry and with the use to be made of the statistics is in a better position to gather them than is a statistical bureau. There is some advocacy of placing all statistical activities under the Bureau of the Census.

In the case of the figures of the United States Geological Survey, covering the total production of electricity by central station and electric railway power plants for 1922, issued June 20, 1923, an aggregate of 47,659,000,000 kw.-hr. was arrived at. The census figures, which were issued four months later, showed a total of 45,308,000,000 kw.-hr. This difference of approximately 5 per cent led to demands from the industry for an explanation. On revising its figures, the Census Bureau is understood to have found that the total should have been 47,375,000,000 kw.-hr. This narrowed the difference between the two bureaus to 283,000,000 kw.-hr., or only 0.6 per cent. The revision of the Survey figures showed one duplication of 75,000,000 kw.-hr. That

resulted from a company in Illinois which purchased that power including it in its report of generated power. The Survey figures include certain plants not included in the Census figures. Allowance for those two items brings the Census and Survey figures to within 15,500,000 kw.-hr., or 0.03 per cent.

Power Project Applications Rejected

In order to clear its records, the Federal Power Commission has authorized the rejection of a number of applications for preliminary permits for licenses. These applications refer to projects which the applicants are not prepared to develop or for which the market will not justify development within a reasonable time. Before the action was taken, the applicants were advised that rejection was contemplated because of lack of evidence of their ability to carry out their proposals within a reasonable time. In the following cases, the applicants raised no objection and the applications have been rejected: Alabama Power Co., proposed project on Coosa River near lock 2; Southern California Edison Co., Salmon Creek reservoir and Horse Creek diversion; San Joaquin Light and Power Co., main stream of Kings River; City of Denver, South Platte River.

Despite a vigorous protest from Duncan Young and Company, the commission has rejected its application proposing a comprehensive development of the Delaware River. This application has been pending nearly four years and still the applicant is unable to complete the application satisfactorily.

World's Coal Production in 1923

The incomplete information now available indicates that the world's total production of all coal in 1923 was approximately 1,335,000,000 metric tons.

The following table prepared by W. I. Whiteside of the Section of Foreign Mineral Reserves summarizes the information received by the Geological Survey up to and including March 1.

COAL PRODUCED IN THE PRINCIPAL COUNTRIES OF THE WORLD IN THE CALENDAR YEARS 1921, 1922 AND 1923

(In metric tons of 2,204,622 lb.)

Country	1921	1922	1923
North America:			
Canada: Coal	10,684,259	10,587,611	15,542,294
Lignite	2,975,598	3,162,907	.....
United States: Anthracite	82,076,000	49,607,344	86,585,000
Lignite and Bituminous	377,316,000	383,073,174	494,772,000
South America:	2,040,598	1,917,493	(a)
Europe:			
Belgium	21,750,410	21,208,500	22,916,070
Czechoslovakia: Coal	11,648,399	9,906,261	11,624,748
Lignite	21,050,712	18,942,920	16,202,496
France: Coal	28,211,839	31,163,032	37,714,393
Lignite	748,634	777,813	862,422
Germany: Coal (b)	136,227,231	129,964,597	55,000,000
Lignite	123,010,036	137,207,125	125,000,000
Saar	9,574,484	11,240,000	8,950,000
Poland	7,842,533	23,800,000	d 37,000,000
Russia	7,611,900	8,914,600	11,707,200
United Kingdom: Great Britain	165,781,404	253,613,054	282,970,535
Ireland	89,958	(a)	(a)
Asia:			
British India	19,612,759	19,316,112	d 19,000,000
China	19,876,375	21,300,000	(a)
Japan (inc. Taiwan and Karafuto) (c)	27,418,000	29,150,000	28,000,000
Africa:			
Union of South Africa	10,339,044	8,830,774	10,800,000
Oceanica:			
Australia	13,084,210	12,496,417	(a)
Total	1,132,400,000	1,223,000,000	1,335,000,000

(a) Estimate included in total. (b) Of which the Ruhr produced as follows: 1921, 94,114,785 tons; 1922, 97,346,176 tons; 1923, 40,000,000 tons (see text). (c) Exclusive of lignite from Japan (annual production of about 200,000), for which estimate is included in total. (d) Estimated from figures for first 11 months.

Fuel-Saving Conference Held by A.I. & S.E.E.

The fuel-saving conference under the auspices of the Combustion Engineering Section of the Association of Iron and Steel Electrical Engineers was held at the William Penn Hotel, Pittsburgh, Pa., April 2 and 3.

The meeting was opened with a short address by R. S. Shoemaker, president, who outlined briefly the purpose of the conference and told of some of the work the Combustion Engineering Section has undertaken and what progress was being made.

In the absence of the general chairman of the section, G. R. McDermott, the secretary, W. P. Chandler, presided.

The first paper of the meeting on "Measurement of Input and Output of Boiler Rooms," was read by J. M. Spitzglass, of the Republic Flow Meters Co., and dealt principally with the application of orifice meters in measuring the flow of steam, water, gas, etc. He also dealt at some length on the measurement of coal to the furnace and described a new type of coal meter which his company is developing to measure the coal by volume instead of by weight.

B. G. Bronlinson, engineer for Aktiebolaget Ljungstroms Angturbin, Wellsville, N. Y., presented a paper dealing with the mechanical and economical features of the Ljungstrom air preheater. Several slides were shown illustrating a number of installations of this heater with different types of boilers.

At the Wednesday afternoon session an interesting talk on the "Prevention of Scale Formation by Water Conditioning," was given by Dr. R. E. Hall, physical chemist, United States Bureau of Mines. His talk related to the results of a series of tests conducted jointly by the Bureau of Mines and the Hagan Corporation on two boilers at the plant of the Mesta Machine Co., Homestead, Pa. Dr. Hall stated that the treatment used was based on the sulphate concentration only, of the boiler water. An abstract of this paper will appear in a later issue.

At the conclusion of the afternoon session a visit was made to the new Cecil Plant of the Allegheny County Steam Heating Co., Duquesne Way and Cecil Place, Pittsburgh. The boiler of 32,750 sq.ft. of heating surface installed in this plant is fired with pulverized coal.

Engineers for St. Lawrence Selected by Weeks

THE Secretary of War has designated Col. Edgar Jadwin, Col. William Kelly and Lieut. Col. George B. Pillsbury as the American members of the engineering board which will revise the estimates contained in previous reports on the St. Lawrence River. This work is to be done under the direction of Commerce Secretary Hoover, who is the chairman of the St. Lawrence commission, appointed recently by the President. The other three members of the board are Canadian engineers.

Deschutes River Ready for Development

An application for license has been filed with the Federal Power Commission by the Columbia Valley Power Co. to cover its proposed development on the Deschutes River in central Oregon. The company in its application states that it is ready to proceed with the construction of the works to be erected on the Pelton site, where it is planned to construct dams 125 ft. high to develop 51,000 hp. Arrangements have been made with industry which insures a market for all of the power which will be developed.

On completing that part of the project, the company plans to proceed immediately with work on the Metolius dam, the larger part of the project, where it proposes to build an arch dam 270 ft. high and to develop 120,000 hp. The engineering work on the project is to be done by Parsons, Brinkerhoff, Clapp and Douglas.

An Engineer Again Heads Reclamation Service

Dr. Elwood Mead, Professor of Rural Institutions, University of California, and until recently Chairman of the State Land Settlement Board, has been granted a leave of absence to become Commissioner of Reclamation, Department of the Interior, at a salary of $11,000. He takes office immediately.

D. W. Davis, the business man recently occupying this position and chosen by Secretary Work to replace Arthur P. Davis, the former Director of the Reclamation Service, has been placed in charge of the Division of Finance which will be the Reclamation Service's agent for collection.

Never before in the history of the federal government has a discharged employee been so honored as has A. P. Davis, the former engineer director of the Reclamation Service. His departure from Washington to reside permanently in California was made the occasion for

various tributes indicative of the appreciation in which he is held by fellow engineers and by his former associates in the Bureau of Reclamation.

More than 500 engineers attended a formal dinner April 5, at which Mr. Davis was the guest of honor. The dinner was under the auspices of the District of Columbia Section of the A.S.C.E. and the Washington Society of Engineers. On that occasion, Commerce Secretary Hoover, former Interior Secretary James Garfield, Carl E. Grunsky, president of the A.S.C.E., and M. O. Leighton, lauded his long and successful public service.

Great Falls to Be Studied by Chamber of Commerce

The Washington Chamber of Commerce recently instructed Charles W. Clagett, chairman on the development of Great Falls, to appoint committees to investigate the various phases of the proposed development of Great Falls for water-power use, and if the report shows that the project is feasible and economical, to have the chamber get firmly behind it.

Standardization of Shafting Report Issued

A preliminary report on the standardization of shafting has just been completed by a subcommittee of the A.S.M.E. organized under the procedure of the American Engineering Standards Committee. This committee has been at work for over four years, and its work supplements that of an earlier war committee organized in 1918 to standardize shafting with a view to conserving steel.

In the preparation of this report the committee has reviewed the whole subject of shafting design, including the many theories of elastic failure. Design formulas for the general cases met with in the design of transmission shafting are included as well as the working stresses recommended for widely varying quality of shafting materials and conditions of loading.

A thorough analysis of the various theories of elastic failure indicates that for ductile ferrous material under widely varying conditions of stress, elastic failure takes place in shear and not in tension or compression. Torsion tests made upon very thin tubes seemed to indicate that the elastic limit in shear of a ductile material is almost exactly one-half of its elastic limit in tension. The conclusion reached is that the "Maximum Shear Theory" is of general application to the various conditions of stress to which a shafting may be subjected. It follows that for uniform stress distribution, the working stresses in shear should be taken as one-half of the tensile stresses.

A limited number of advance copies of the report have been prepared and are being sent out for criticism to those members of the A.S.M.E. interested in the subject. The object is to give these members an opportunity to offer criticisms before final printing. A few of these advance copies are still available and will be sent to those members interested.

To Study Smoke in Relation to Low-Pressure Boilers

An investigation by the Mellon Institute of Industrial Research, University of Pittsburgh, of the relation of low-pressure heating boilers, the type in general use in all residences, apartment houses and office buildings, to the city smoke problem, has been announced by the director.

H. B. Meller, Chief of the Pittsburgh Bureau of Smoke Regulation and also connected with the Mellon Institute, after a conference with manufacturers of low-pressure boilers, is asking each one to furnish information concerning evaporation, grate area, total coal required in pounds per hour, draft and effective area of smoke pipe and chimneys for each type and size. Tests will be made according to the A.S.H.&V.E. Code for Testing Low-Pressure Boilers. This information will be tabulated and published, for the information of the public interested, by the Institute.

It is anticipated that this investigation will result in standardization of information that will be of value to the public everywhere, as it will state the requirements of heating boilers in terms that the layman can understand. The industrial aspect of the subject will receive simultaneous attention under the supervision of Mr. Meller.

Owing to the waning supply of natural gas in the Pittsburgh district a constantly growing number of private dwellings, hotels, apartments, stores and office buildings are turning to coal and coal-fired boilers for heating purposes and the smoke question is growing more acute. As one of the causes of dense smoke in a community is the heating boiler, it is hoped not only to lessen the consumption of fuel, but to reduce the smoke by a more thorough dissemination of information of boiler requirements.

California Petitions Vote on Water and Power Act

INITIATIVE petitions to place the water and power act on the November, 1924, ballot appeared on the streets of San Francisco and Oakland on April 8 and will be circulated in the larger cities of California to obtain the 770,263 signatures necessary. The new act is virtually the same as the one that was defeated by a vote of about three to one two years ago. It is summarized as follows: A water and power initiative measure amending the state constitution and creating a board of five appointed by the Governor and subject to recall, which is authorized to develop and distribute water and electric energy, acquire by any legal means any property therefor and do anything convenient thereto including using and reserving state lands and waters; it gives the state and political subdivisions certain preferential rights as against privately owned public utilities selling water or electric energy to the public; it authorizes the issuance of state bonds not exceeding $500,000,000 to further such purposes and requires the board to fix rates to meet expenses and retire the bonds in fifty years.

Interconnection in France Nearing Completion

There is rapidly being completed a superpower system in France, which starting from interconnected hydro-electric central stations in the east and south of France, forms a network of high-power transmission lines that will distribute current as far as Brittany and the West Coast.

Out of the nine million hydro-electric horsepower available in France, nearly two millions have already been harnessed, and it is expected that by the end of the year the total will have reached three million, with an estimated saving of coal amounting to 18,000,000 tons a year.

More than two hundred applications for water-power development have been filed which will add 1,500,000 hp. to the present output and in the Maritime Alps four sites are under development, the ultimate output of which will be 500,000 hp.

How the hydro-electric business of France is growing is shown by the fact that twenty years ago only 200,000 hp. was produced in France from hydro-electric plants, but it is predicted that this will increase to 4,000,000 hp. within the present decade.

Pittsburgh Claims World's Biggest Boiler

The new Cecil plant of the Allegheny County Steam Heating Co., the first unit of which was recently completed and put into operation, was visited on April 5 by members of the Engineers' Society of Western Pennsylvania. The plant, which is on the Allegheny River, close to the heart of Pittsburgh, will supply central-station steam-heating service to the downtown business district. The unit now erected, which is one-quarter of the ultimate plant, contains a single water-tube boiler which is said to be the largest in the world, having a total heating surface of 32,750 sq.ft., including that in the water screens and water-tube walls. The present working pressure is 150 lb., but all equipment is designed for a future pressure of 190 lb.

The boiler is fired with pulverized fuel. Coal received by rail or barge is carried through a tunnel from the river bank to the power plant. The pulverized-fuel equipment of the first unit consists of two six-roll pulverizing mills, two mill exhaust fans, two cyclone collectors, two screw conveyors, and two eight-unit coal feeders. Below the water screen are six hoppers, each equipped with an air-operated gate. The furnace walls are insulated, the side and rear walls being protected by water-cooling tubes on the inner surface. The great size of the unit is evident from the furnace volume of 19,350 cu.ft. and from the fact that the cross-drum is 34 ft. by 60 in.

Grand Falls Will Be Publicly Owned

Definite announcement that the government of New Brunswick will undertake development of Grand Falls on the St. John River as a public-ownership proposition has been made by the prime minister of the province. It is intended to develop at present the power which would come from storage possibilities on purely Canadian territory which would run from 60,000 to 80,000 hp.

Internal-Combustion Engine at World Power Conference

The American program committee of the World Power Conference, in view of the rapid development of the internal-combustion engine, have felt that the subject was worthy of discussion at the coming World Power Conference to be held in Wembley, England, from June 30 to July 12, and have asked Dr. Charles Lucke to prepare a paper on the general subject of the status of the internal-combustion engine at the present time.

Czechoslovakia Plans Congress for July

An invitation for the engineering societies of the United States to unite with the Czechoslovak Society of Engineers and Architects, under the auspices of the Czechoslovak government, in an International Management Congress has been issued by the Masaryk Academy to the American Engineering Council.

The proposed conference is to be held in Prague the latter part of July at such time that engineers who attend the World Power Conference in London from June 30 to July 12 will be able to include the International Management Congress in their plans. Management problems in manufacturing and allied pursuits will be the general topic. Robert T. Kent has been named by the A.S.M.E. as the delegate to represent it at this co[illegible]

Per[illegible]tion

Jack Armour's many friends will be glad to know that he has returned north after recuperating in Florida from his recent illness and that he is now much improved.

J. J. Chisholm, formerly field engineer of the Westcott & Mapes Co., New Haven, Conn., has identified himself as superintendent of power with the United Verde Copper Co., of Clarkdale, Arizona.

N. D. Holmes has resigned as chief engineer of the Farmington steam plant of the Central Maine Power Co. to join the New England Power Co. as operating superintendent of the Davis Bridge development near Readsboro, Vermont.

Raymond S. Reed is now in the mechanical division of Stone & Webster, Inc., Boston, Mass. Mr. Reed was formerly with the Solvay Process Co., Syracuse, where he made extensive studies of power-plant engineering problems.

Coming Conventions

American Association of Engineers. C. E. Drayer, 63 East Adams St., Chicago, Ill. Annual meeting at San Francisco, May 12-14.

American Chemical Society. Charles L. Parsons, 1709 G St. N.W., Washington, D. C. Annual meeting at Washington, D. C., April 21-25.

American Electrochemical Society. C. G. Fink, Columbia University, New York City. Meeting at Hotel Bellevue-Stratford, Philadelphia, Pa., April 24-26.

American Order of Steam Engineers. W. S. Wetzler, 753 North 44 St., Philadelphia, Pa. Annual meeting at Moose Hall, 1314 North Broad St., Philadelphia, Pa. June 2-7.

American Society of Mechanical Engineers, Calvin W. Rice, 29 West 39th St., New York City. Spring meeting at Cleveland, Ohio, May 26-29.

American Society of Refrigerating Engineers. W. H. Ross, 35 Warren St., New York City. Annual meeting at Cleveland, Ohio, May 27-29.

American Water Works Association. J. M. Diven, 153 West 71st St., New York City. Annual convention at New York City, May 19-21.

American Welding Society, Miss M. M. Kelly, 29 West 39th St., New York City. Annual meeting at New York City, April 23-25.

Electric Power Club. S. N. Clarkson, Keith Bldg., Cleveland, Ohio. Meeting at Seaview Golf Club, Absecon, N. J., May 26-29.

International Railway Fuel Association. J. B. Hutchinson, 6000 Michigan Ave., Chicago. Annual convention at Hotel Sherman, Chicago, Ill., May 26-29.

Master Boiler Makers Association. H. D. Vought, 26 Cortlandt St., New York City. Meeting at Chicago, May 20-23, 1924.

National Association of Stationary Engineers. Fred W. Raven, 417 South Dearborn St., Chicago, Ill. Annual convention and exhibition at Hotel Pantlind, Grand Rapids, Mich., Sept. 8-13. Annual conventions and exhibitions of the state associations are scheduled as follows: **Kansas Association** at Parsons, Kans., April 16-18. J. M. VanSant, 739 Horne St., Topeka, Kan. **Indiana Association** at Lafayette, Ind., May 5-6. Prof. A. W. Cole, Purdue University, Lafayette, Ind. **New Jersey Association** at Newark, June 6-8. Joseph P. Flynn, 612 Franklin St., Elizabeth, N. J. **Iowa Association** at Sioux City, June 10-14. Abner Davis, 16 Waterhouse Block, Cedar Rapids, Iowa. **Ohio Association** at Akron, June 19-21. T. S. Garrett, 2622 East Second St., Dayton, Ohio.

National District Heating Association, D. L. Gaskill, 112 West Fourth St., Greenville, Ohio. Annual convention at New York City, June 10-12, 1924, formerly announced June 11-14.

National Electric Light Association. M. H. Aylesworth, 29 West 39th St. New York City. Annual convention at Atlantic City, Young's Million-Dollar Pier, May 19-24. **Nebraska Section,** H. M. Davis, Banker's Life Bldg., Lincoln, Neb. Sectional meeting at Omaha, May 8-9. **Southwestern Division,** S. J. Ballinger, San Antonio Public Service Co., San Antonio, Texas. Divisional meeting at New Orleans, April 22-25.

Society of Industrial Engineers. George C. Dent, 608 South Dearborn St., Chicago, Ill. Eleventh annual convention at Hotel Statler, Buffalo, N. Y., April 30 to May 2, 1924.

Stoker Manufacturers Association. G. A. Sacchi, Westinghouse Elec. & Manufacturing Co., Philadelphia, Pa. Annual meeting at Edgewater Beach Hotel, Chicago, Ill., June 2-4.

World Power Conference. O. C. Merrill, Federal Power Commission, Washington, D. C. British Empire Exhibition, Wembley, London, June 30-July 12.

Obituary

Charles A. Munn, editor and publisher of the *Scientific American,* died after a brief illness at his home on April 2. Mr. Munn was 64 years old. He was graduated from Princeton in 1881 and had devoted the past 43 years to the magazine, which was founded by his father.

J. L. Moore, president of the Moore Steam Turbine Corp., Wellsville, N. Y., died suddenly on April 2, after an illness of only a few days. Mr. Moore went to Wellsville about twenty years ago in the capacity of general manager and chief engineer of the Kerr Steam Turbine Co., where his splendid work helped to place that company in the front ranks of the small turbine industry. Between seven and eight years ago he incorporated a company and built a plant of his own. This company, from its inception, has made splendid progress and has been the source of gratification to its stockholders. He leaves, besides many mourning friends and associates, a widow and one daughter.

Society Affairs

The Philadelphia Section of the A.S.M.E. will hold its April 22 meeting at the Engineers' Club. "Steam and Diesel-Driven Ships" will be the topic.

The Hartford Engineers' Club will hear L. W. Wallace, speak on the "Work of the American Engineering Council and the Place of Both Local and National Organizations of Engineering," at its April 23 meeting.

The Metropolitan Section of the A.S.M.E. will hold a dinner meeting on April 22, formerly announced for April 24, at the Building Trades Club. Dr. Charles Lucke, of Columbia University, will speak on "Oil Engines."

The Knoxville Section of the A.S.M.E. will have as the topic for its April 21 supper meeting, "Application of Steam and Electric Power to Woolen Mills." W. E. Biggs, of the W. E. Biggs Engineering Co., will be the speaker.

The Western Washington Section of the A.S.M.E. will hold a "Steam Engineering" session on April 26. T. H. Bradley will take as his topic "Steam Problems in a Puget Sound Sawmill"; George H. Krueger will also speak at this meeting.

The Affiliated Technical Societies of Boston will hold a joint dinner meeting, probably at Lorimer Hall, Tremont Temple, with the Associated Industries of Massachusetts on April 29, to discuss the Report of the Power Investigating Committee of the Associated Industries.

The Baltimore Section of the A.S.M.E., at its April 25 meeting, will hear papers on "Design & Construction of 13,200-volt Switchhouse," and "Installation of Two New 20,000-kw. Hydraulic Turbines," by A. S. Loizeaux and A. L. Penniman, Jr., of the Consolidated Gas, Electric Light and Power Co. There will also be an inspection trip to the Westport power station.

Trade Catalogs

Compressors—Bury Compressor Co., Erie, Pa. Leaflet describing air and gas compressors and vacuum pumps.

Burner, Coal—Buffalo Forge Co., Buffalo, N. Y. Form 1875 describes the operation and use of this coal burner for burning small sizes of coal.

Pipe Cutters—The Borden Co., Warren, Ohio. Leaflet describing the square-end pipe cutters made by this company.

Insulators, Porcelain—Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. Special publication 1690 describes high-voltage porcelain insulators, their design and manufacture.

Refrigerating Machine—York Manufacturing Co., York, Pa. Bulletin No. 69 gives a description of the vertical single-acting enclosed ice-making and refrigerating machine, type Y-16, built by this company.

Slotter, Commutator—The Martindale Electric Co., Box 35, Lakewood Branch, Cleveland, Ohio. Bulletin describing U- and V-shaped slotters, slotting files, cleaning tools, blowers, cements, beads and varnish.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Mar. 31, 1924	Apr. 7, 1924
Pool 1	New York...	$3.75	$3.00
Smokeless	Columbus....	2.25	2.50
Clearfield	Boston.....	2.35	2.50
Somerset	Boston.....	2.50	2.50
Kanawha	Columbus....	1.70	1.80
Hocking	Columbus....	1.75	1.75
Pittsburgh No. 8	Cleveland...	1.90	1.85
Franklin, Ill.	Chicago....	2.50	2.50
Central, Ill.	Chicago....	2.25	2.25
Ind. 4th Vein	Chicago....	2.50	2.50
West Ky.	Louisville...	1.85	1.75
S. E. Ky.	Louisville...	2.00	1.75
Big Seam	Birmingham	2.25	2.25

FUEL OIL

New York—April 10, light oil, tank-car lots, 28@34 deg. Baumé, 5½c. per gal., 36@40 deg. 6c. per gal., f.o.b. Bayonne, N. J.

St. Louis—March 25, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.90 per bbl.; 26@28 deg., $1.95 per bbl.; 28@30 deg., $2 per bbl.; 32@36 deg., gas oil 5½c. per gal.; 38@40 deg., 6½c. per gal.

Pittsburgh—April 3, f.o.b. local refinery, 30@34 deg., fuel oil, 5½c. per gal.; 34@40 deg., fuel oil, 6c. per gal.; neutral, 9c. per gal.

Cincinnati—March 25, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 6c. per gal.; 26@30 deg., 6½c. per gal.; 30@32 deg., 6¾c. per gal.

Dallas—April 4, f.o.b. local refinery, 26@30 deg., $1.30 per bbl.

Philadelphia—March 28, 28@30 deg., $2.31@$2.36 per bbl.; 18@22 deg., $2.10 @$2.16½; 13@16 deg., $1.68@$1.74½ per bbl.

Boston—April 7, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4⅞c. per gal., light oil, 28@32 deg Baumé, 6⅞c. per gal.

New Plant Construction

Ala., Birmingham—The Jefferson County Commissioners contemplate the installation of steam power equipment in connection with the proposed addition to the Hillman Hospital, estimated to cost $500,000. H. B. Wheelock, Birmingham, is architect.

Ala., Florence—The Board of City Commissioners plans for the installation of electric-operated pumping equipment in connection with proposed extensions in the municipal water works, estimated to cost $100,000.

Ala., Jasper—The Deep Water Coal Co., recently organized, has engaged Robert W. Hunt & Co., 175 West Jackson Blvd., Chicago, Ill., to make tests of its coal properties in Walker, Marion and Winston Counties, and prepare plans for the installation of a plant. The project will include a power house in addition to coal-handling plant, previously announced, with pumping station and other power departments, reported to cost $500,000. L. B. Musgrove, Jasper, is president.

Calif., Bartle—The Mount Shasta Silica Co., Weed, Calif., recently organized plans for the construction of a steam-operated power house at its proposed local commercial silica works, estimated to cost about $85,000. Fred M. Miller is engineer.

Calif., Downieville—The Sovereign Comet Gold Mining Co. plans for the installation of a hydro-electric power plant for service at its properties, to be located in the Jim Crow Canyon. Application has been made to the State Water Department for permission.

Calif., Huntington Park—The Western Cooperage Co., 1919 Bay Ave., Los Angeles, will build a one-story boiler plant, 25 x 40 ft., at its proposed local works, estimated to cost $80,000, for which a general erection contract has been awarded to the Austin Co., Bartlett Bldg., Los Angeles. It is expected to proceed with the structures at once.

Calif., Los Angeles—The Sperry Flour Co., 141 California St., San Francisco, plans for the construction of a steam power house at its proposed flour mill and operating plant on site recently acquired at Maywood and Fruitland Aves., estimated to cost $950,000. The present plant at Seventh and Alameda Sts., will be removed to the new location.

Calif., Merced—The Merced Irrigation District is arranging for a bond issue of $3,500,000, a portion of the proceeds to be used for the construction of a hydro-electric power plant. A special election has been called to approve the issue.

Calif., Ontario—The Ontario Power Co. is completing plans for the construction of a steam-operated electric power plant, with initial capacity of about 4,000 kw., to cost close to $100,000. Glenn D. Smith is manager.

Calif., Oroville—The Middle Feather River Power Co. is perfecting plans for the early construction of its proposed hydro-electric power plant on site about 16 miles from Oroville, with ultimate capacity of 400,000 hp., estimated to cost $2,500,000. William Watson, Quincy, Calif., is engineer in charge of surveys.

Calif., San Francisco—The Pacific Portland Cement Co., Consolidated Pacific Bldg., is reported to be planning for the construction of a power house at its proposed plaster mill on site in Southern California, estimated to cost close to $750,000. Robert B. Henderson is president.

Calif., San Francisco—The Pacific Gas & Electric Co., 445 Sutter St., has entered into agreement with the Nevada County Irrigation District for the joint construction of a hydro-electric generating plant and irrigation system, estimated to cost $8,000,000, using waters from the South and Middle Forks of the Yuba River. Application will soon be filed with the State Railroad Commission for permission.

Calif., Yreka—The Common Council has tentative plans under advisement for extensions and improvements in the municipal waterworks, with the installation of electric-operated pumping equipment and accessory apparatus. Bonds will be voted. The Chamber of Commerce is interested in the project.

D. C., Washington—The Bureau of Supplies and Accounts, Navy Department, will take bids until April 22, for 6,850 ft. copper steam hose for the South Brooklyn navy yard; 5,220 ft. similar hose for the Hampton Roads, Va., navy yard; and 350 ft. fuel oil hose for the Mare Island navy yard, all as set forth in Schedule 2048.

D. C., Washington—The general purchasing officer, Panama Canal, will take bids until April 18, for 5 electric motors, 750 ft. leather belting, 1,000 lbs. rubber packing, and other equipment as specified in Circular 1600. Also, until April 29, for a quantity of fire brick, magnesia pipe covering, babbitt metal, and other material as set forth in Circular 1602.

Egypt, Mehalla El Kobra—The Municipal Government is asking tenders (no closing date stated) for pumping machinery and power equipment for a proposed waterworks, as per specifications on file at the office of the Bureau of Foreign and Domestic Commerce, 734 Customhouse, New York.

Fla., Daytona—The City Council plans for the installation of electric-operated pumping equipment in connection with extensions and improvements in the municipal waterworks and sewerage plants, estimated to cost $600,000. Harrington, Howard & Ash, Orear-Leslie Bldg., Kansas City, Mo., are consulting engineers.

Fla., Jacksonville—The Ford Motor Co., Highland Park, Detroit, Mich., will soon break ground for a power house at its proposed local assembling works, estimated to cost about $100,000. Albert Kahn, 1000 Marquette Bldg., Detroit, is architect.

Fla., Jacksonville—The Mumby Ice Co. has commenced foundations for a one-story ice-manufacturing plant on Eighth St., to be equipped for a daily output of 35 tons. It will cost about $55,000. James K. Stathis is president.

Fla., Lake Wales—The Florida Ice & Power Co. is planning for enlargements in its steam-operated power plant to increase the capacity about 50 per cent. A turbo-generator and accessory equipment will be installed.

Fla., Miami Beach—The American Light & Power Co. is perfecting plans for extensions in the power plant of the Miami Beach Electric Co., recently acquired, to include the installation of a 5,000 kw. steam turbo-generator and auxiliary equipment. C. E. Groesbeck is president.

Fla., Seabreeze—The Common Council contemplates the installation of electric-operated pumping machinery in connection with waterworks extensions, for which a bond issue of $35,000, has been approved.

Fla., St. Petersburg—The Department of Public Utilities, R. E. Ludwig, director, plans for the installation of pumping equipment in connection with extensions in the sewerage system.

Ga., Augusta—The H. H. Claussen Co., 1589 Broad St., operating a baking plant, plans for the installation of steam power equipment, rotary ovens and a cold storage plant at its proposed new addition, to cost in excess of $35,000.

Ga., Blakely—E. P. Martin is planning for the purchase of a Corliss engine and auxiliary equipment for installation in a local lumber mill.

Ga., Columbus—The Columbus Electric & Power Co. has plans maturing to begin construction within the next few months of a power dam on the Chattahoochee River, with hydro-electric power station of

30,000 kw. initial capacity, to be doubled in output at a later date. The project will involve about $4,500,000.

Ga., Dublin—The Wrightsville & Tennille Railroad Co., Tennille, Ga., plans for the construction of a power house at its proposed local locomotive repair shops, estimated to cost $90,000.

Ga., Elberton—The Common Council is considering the installation of electric-operated pumping equipment in connection with proposed extensions in the municipal waterworks, for which a bond issue has been arranged.

Ga., Millen — The Central of Georgia Railway Co., Savannah, Ga., has tentative plans for the construction of a local 500-ton coaling station, with mechanical elevating and conveying equipment, to cost in excess of $175,000.

Ill., Chicago—The Norwegian Lutheran Home and Hospital, 1138 North Leavitt St., will soon commence the erection of a power house at its proposed five-story and basement institutional building at 1100 North Leavitt St., to cost $200,000. John Krippner, 2204 South Crawford St., is structural engineer.

Ill., Metropolis—A. N. Starkes, mayor, will receive bids until April 24, for a municipal waterworks and extensions to the city power plant, including two water-tube boilers, each 200 hp. capacity; coal elevating and conveying machinery; engine and generator, with accessory apparatus; surface condenser; closed type heater; boiler feed pumps and four centrifugal pumps, motor-driven; steam and water specialties, piping, valves, etc.; one 500 kw. uniflow generator unit; switchboard and auxiliary apparatus, all as per specifications on file at the office of the W. A. Fuller Co., Railway Exchange Bldg., St. Louis, Mo., engineer.

Ill., Plymouth — F. M. Connolly, 432 Peoples' Bank Bldg., Galesburg, Ill., architect, has plans under way for the construction of a local rock crushing plant, at which it is proposed to build a steam power house. The project will be carried out by a company now being organized, and it is estimated to cost $150,000. J. J. Sullivan will be superintendent at the works.

Ind., Indianapolis — The Real Silk Hosiery Mills, Inc., 614 North Noble St., has had plans prepared for the erection of a one-story steam power house, with 150 ft. high, self-supporting steel stack, in connection with mill extensions, estimated to cost $125,000. Lockwood, Greene & Co., 38 South Dearborn St., Chicago, Ill., are engineers.

Ind., Jeffersonville—The Interstate Power Co., Indianapolis, has plans in progress for the construction of a new steam-operated generating plant on local site to cost $600,000, with equipment.

Ind., North Vernon—The Louisville Gas & Electric Co., Louisville, Ky., has negotiations under way for the purchase of the local municipal power plant, and plans for extensions in this district.

Iowa, Marshalltown—Bonds for $300,000 have been approved by citizens at a special election, the proceeds to be used for extensions and improvements in the municipal waterworks, including a low-lift motor-driven pumping station. O. G. Herm is engineer. A. T. Luce is waterworks superintendent.

Iowa, Mt. Pleasant—The Iowa Electric Co., Cedar Rapids, is arranging a fund of about $200,000, for extensions and improvements including additional equipment in its hydro-electric power plant on the Skunk River.

Kan., Brookville—The Common Council plans for the installation of electric-operated pumping equipment in connection with waterworks extensions, for which plans are being prepared by the Ruckel Engineering Co., Interurban Bldg., Hutchinson, Kan.

Kan., Wichita—The Wichita Water Co. is selling a bond issue of $1,400,000, a portion of the fund to be used for proposed extensions and improvements in waterworks, including the installation of electric-operated pumping equipment.

Ky., Burnside—The Cumberland Hydro-Electric Co., 1011 Fletcher Bldg., Indianapolis, Ind., is said to be perfecting plans for the construction of the first of its proposed hydro-electric power plants near Burnside, on the Cumberland River, for which a preliminary permit from the Federal Power Commission has been granted.

La., Lake Charles — The Lake Charles Rice Milling Co. is reported to be planning for the construction of a steam-operated power house in connection with the proposed rebuilding of the portion of its local mill recently destroyed by fire with loss in excess of $500,000, including equipment.

Mass., Southbridge — The Southbridge Printing Co. is arranging for the immediate installation of an oil-burning system at its power pant in the Sandersdale section, changing from coal fuel.

Mich., Cadillac—The Gluetite Panel & Veneer Co. has tentative plans for the rebuilding of the portion of its local woodworking mill and boiler house, destroyed by fire, March 17, with loss of about $75,000.

Mich., East Haven—The Common Council has tentative plans for the rebuilding of the municipal electric light plant, recently destroyed by fire. An official estimate of loss has not been announced.

Mich., Zilwaukee—The Consumers Power Co., Jackson, Mich., is taking bids on a general contract for the construction of a one-story steam-operated generating plant on local site, estimated to cost $1,000,000, with equipment.

Minn., Owatonna — Bids will be asked for the construction of the proposed municipal electric power plant before the close of the month, estimated to cost $350,000, for which plans are being completed by Arthur L. Mullergren, Kansas City, Mo., engineer. C. J. Servatius is city clerk.

Minn., St. Paul—George J. Ries., county auditor, will receive bids until April 21, for pumping equipment to be used for municipal service at the White Bear Lake.

Miss., Fayette—The Common Council has tentative plans under advisement for extensions in the municipal power station, to include the installation of additional equipment.

Miss., Natchez—The Southern Railway & Light Co. is taking bids on a general contract for the construction of a one-story steam-operated power plant. Orders for equipment will be placed at a later date. John M. Marriott, Frost Bldg., San Antonio, Tex., is architect.

Miss., West Point—The West Point Tile Co. contemplates the construction of a steam-operated power house at its proposed tile and brick manufacturing plant, estimated to cost $40,000. E. M. Powell is president.

Mo., Cameron — The Board of Public Works has completed plans and will break ground at once for the construction of a municipal steam-operated power plant, estimated to cost in excess of $35,000.

Mo., Chaffee—The Common Council is considering the installation of electric-operated pumping equipment in connection with proposed extensions in the waterworks and sewerage systems, estimated to cost $35,000.

Mo., Kansas City—The Stop & Shop Co., H. B. Scholfield, president, plans for the installation of an ice and refrigerating plant in its new public market building to be erected at Main and Spring Sts., 140 x 240 ft., estimated to cost $500,000. The plant will have an initial output of 40 tons per day. The W. S. Ferguson Co., Cleveland, Ohio, is architect.

Mo., Kennett—The Common Council has tentative plans for the installation of electric-operated pumping equipment in connection with extensions in the waterworks and sewerage plants, for which bonds for $35,000 have been voted.

Mo., St. Joseph — The Mueller-Keller Candy Co., 609 North Second St., is considering the purchase of two 300 hp. boilers and auxiliary equipment for installation at its power house. Fred Keller is president.

Mont., Missoula—The Dover Lumber Co. plans for the construction of a boiler plant at its proposed mill at Marten Creek, estimated to cost $75,000.

N. H., Manchester—Manchester Traction Light & Power Co. has awarded contract to Stone & Webster, Inc., Boston, Mass., for the installation of one 2,400-kw. and one 3,200-kw. turbine at its hydro-electric plant at Garvin's Falls on the Merrimac River, and the installation of one 1,000-kw. turbine at Kelly's Falls on the Piscataquog River to replace old equipment. The contract also covers a modification of the building at Garvin's Falls.

N. J., Newark—The Standard Bitulithic Co., foot of Brill St., has filed plans for the construction of a one-story boiler house, in connection with a new plant addition.

N. C., Farmville—The City Council will receive bids until April 29 for extensions and improvements in the municipal power plant, including a 250 kw. uniflow engine-generator unit; surface condenser; boilers; vacuum and circulating pumps; valves; separators; electrical apparatus, including switchboard, etc.; and spray equipment for cooling condensing water. William C. Olsen, Raleigh, N. C., is consulting engineer.

N. C., Goldsboro—The Crystal Ice & Fuel Co., recently organized, is perfecting plans for the construction of an ice-manufacturing plant, to cost about $45,000, with equipment. The company will operate with a capital of $100,000. W. L. Rawlings is head.

N. C., Winston-Salem — The Winston-Salem Chair Co. has completed plans for extensions in its steam power house to double the present capacity. Contracts for a portion of the equipment are being let, and other orders will be placed at an early date.

N. D., Minot — The Northern States Power Co. is perfecting plans for the construction of a power house and pipe line from the Mouse River, estimated to cost $65,000. John F. McGuire is local manager.

Ohio, Cincinnati—The Merkel Brothers Co., manufacturer of plumbing and heating equipment, will build a steam-operated power house at its proposed new pipe and manufacturing works, estimated to cost $500,000, for which a general building contract has been awarded to the Austin Co., Cleveland, Ohio. Coal and ash-handling machinery will be installed.

Ohio, Toledo—The Libbey-Owens Sheet Glass Co., Nicholas Bldg., will lay foundations at an early date for a power house and plate glass manufacturing plant at East Broadway and the New York Central Railroad, to cost in excess of $2,000,000, with equipment. A general building contract has been let the A. Bentley & Sons Co., Toledo. Equipment orders will be placed in the near future.

Ore., Newberg — The Newberg Fruit Growers & Packers Association plans for the construction of a boiler plant at its proposed new canning factory on local site, for which plans will be prepared in the near future.

Ore., North Bend—The Mountain States Power Co., Albany, Ore., has authorized surveys and will soon commence the erection of its proposed local steam-operated generating plant, with initial capacity of 6,700 hp., estimated to cost $600,000, with equipment.

Pa., Grove City—Helmer Rabild is considering the establishment of an ice and refrigerating plant, to be operated in conjunction with his present creamery, estimated to cost about $25,000.

Pa., Newport — The Watts Water & Power Co., Harrisburg, Pa., has secured a preliminary permit from the Federal Power Commission for the construction of a hydro-electric power plant on the Juniata River, near Newport, reported to cost in excess of $350,000.

Pa., Philadelphia — The Philadelphia Electric Co., Tenth and Chestnut Sts., has plans nearing completion for the construction of a steam-operated generating plant on site selected on the Delaware River, with output of about 650,000 kw.hr. The reported cost is $750,000.

Pa., Tamaqua—The Lehigh & New England Railroad Co., 437 Chestnut St., Philadelphia, Pa., is said to be planning for the erection of a boiler plant at its proposed local locomotive repair shops, estimated to cost more than $100,000, with equipment.

S. C., Chester—The Chester Ice & Fuel Co. will commence work at once on its proposed ice-manufacturing plant on Ceiter St., to be equipped for a capacity of about 30 tons per day. Henry M. DaVega heads the company.

Tex., Columbus—O. A. Zumwalt, Columbus, and Dr. A. S. McDaniels, San Antonio, Tex., now organizing a company to construct and operate a hydro-electric power plant on the Colorado River, near Columbus, have been granted permission by the State Board of Water Engineers to proceed with the building of a power dam to divert the necessary flow. Plans for the station will be completed at an early date.

Tex., Crockett — The Texas Power & Light Co., Dallas, has acquired the local plant and property of the Crockett Light & Ice Co., for a consideration stated to be $100,000. The purchasing company plans for extensions and additional equipment.

Vt., Morrisville—Bids are being asked by the Board of Water and Light Commissioners until April 17, for a municipal hydro-electric power plant, with power dam, penstock lines, etc., as per plans and specifications at the office of McIntosh & Crandall, Burlington, Vt.

Va., Norfolk—The navy supply officer, navy yard, will take bids at once for 3 steam flow meters, as per N. S. A. requisition 627.